ANALYSIS OF PRINCIPLES OF CONSTRUCTIVE DESIGN OF TRICOT PRODUCTS WITH SHOULDER SUPPORT FOR WOMEN

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Abstract: *The work examines the problem of elaborating the contours of basic templates of shoulder-supported tricot products for women. The scope of this work resides in determining the factors affecting the quality of positioning of tricot products on the wearers' bodies using the graphic constructive elements elaborated by graphic-analytical design methods. The study is based on the comparative analysis of 10 methods of designing shoulder-supported tricot products. The following criteria were used for analyzing the selected methods: structure of initial data, system of add-ons, modality of dimensioning the basic network, the type of calculation relationships for determining the constructive parameters, the methods of determining the location of constructive points and contour tracing. The theoretical study of design methods taken by the study has been completed with experimental aspects of elaboration and verification of quality of placing the products on the mannequins. The study allowed to identify the zones of vulnerability for the product positioning and implicitly, the construction elements generating defects and divergence in the „man-clothing" system in statics. The results of the study establish the premises for optimizing the algorithms for elaborating the basic templates by identifying the optimum connections between the calculation relationships and the shape of surface on the support.*

Keywords: *basic template, constructive additions, design principles, tricots.*

INTRODUCTION

One of the most sophisticated and sensible stages in the manufacturing of garments is the process of obtaining the templates of unfolded elements of garments. The essence of this process consists in obtaining an unfolded surface of any geometrical shape (model). In this case the unfolded surface implies the totality of all plane elements that allow to obtain a geometric object (product) from diverse materials (fabric, tricot, leather, etc.) adequate for the initial object.

The elements of products obtained in the result of construction, when assembled into a product, must provide for the similitude of model's visual characteristics with the final object. The parametric and geometric characteristics of reference elements must provide the following:

- ✓ Anthropometric adequacy of product in static and dynamic conditions;
- ✓ Reliability and functionality of construction in the process of exploitation of product;
- ✓ Dimensional correspondence of reference elements in the connection places at length and contour without additional adjustment, cutting and correction.

The spatial formation methods of the elements must guarantee their logical interdependence with the properties of respective materials. The configuration of reference elements must guarantee the possibility of technological execution of construction in the production process and during wearing.

STRUCTURAL ANALYSIS OF GRAPHIC CALCULATION DESIGN METHODS

Given the diversity and complexity of tasks to be resolved during the design process, the industry involves diverse methods and recommendations for constructing the templates of reference elements of garments. Some of the most accessible and frequently used ones are the *graphic calculation design methods* providing the possibility to construct templates both for the typical and individual bodies with a minimum number of analytical calculations using the graphic construction procedures. The essence of graphic calculation design technology resumes to the determination of positions of the basic reference points on the template surface in relationship with coordinate axes (unfolding lines) with the help of computed relationships or graphic constructions, with their subsequent attachment in the established order. All graphic calculation design methods are easily formalized allowing to automate the template construction process. Although there is a multitude of graphic calculation methods, these differ on the stages of template construction, structure of

initial information, position of coordinate axes, technology of calculating the coordinates of constructive points and dimensions of construction segments, as well as the employed graphic elements.
The process of constructing basic templates includes two to six stages depending on the applied method.
The first stage of preparation of initial data for constructing a template includes the analysis of constructive-compositional characteristics of the materials, data on the shapes and dimensions of human body.
The second stage implies the preliminary calculations of construction elements for establishing the main dimensional characteristics of corsage, its components and sleeve parameters, as well as the evaluation of coordination degree of the major construction elements.
The third stage – calculation and construction of the template's basic network, in accordance with the preliminary calculations.
The fourth stage – calculation and construction of template's basic scheme conditioned by the product cut, by constructing the symmetry lines on the back and on the front, the neck cut line, the sleeve cut line and superior cuts for the bust and shoulders.
The fifth stage – calculation and construction of principal lines for creating the product shape in the waist area.
The sixth stage – quality checking of basic template.
The initial data for the graphic calculation design methods include the body dimensions and shape, the specific values of legerity add-ons and data specific for the project being designed.
In order to characterize the human body the graphic calculation design methods require 2 to 40 measurement parameters. The number of measurement parameters depends on the type of product, its destination, the position of coordinate axes, the technology of determining the coordinates of constructive points and the degree of product personalization.
In practical constructive design of garments the positions of coordinate axes may vary. So, the vertical У axis may pass through the back symmetry line, or the front line of product. In the first case the construction is made from back to front, while in the second case – in the opposite direction.
The X-axis (horizontal) may pass via the cervical point, the lateral point of neck basis, via the bust or waist line. The position of coordinate axes defines the structure of calculation relationships and the graphic procedures of template construction.
In order to determine the ***coordinates of constructive points*** on the template various calculation relationships are used, depending on the degree of precision they are divided into four categories.
The relationships of type I are the most precise, as they imply a direct correlation between the sought coordinates of points and dimensions of human body. The precision of determining the dimensions of product reference points with the help of relationships of this type depends on how correctly have the add-ons been determined for the various product components.
In case of a smaller number of body measurement parameters, most widely spread being the calculation relationships of type II, in a constructive segment they are calculated with the help of an anthropometric parameter that does not directly characterize the respective dimension of reference element. The precision of determining the values of construction segments with the help of type II relationships depends on the exact expression of correlation between the main and secondary anthropometric dimension and the size of constructive add-on, as well as the correctness of its distribution on the constructive segment. Most often these calculation relationships are used in the methods of designing templates for typical bodies where they are interdependent and have a constant character.
The calculation relationships of type III are used for determining the coordinates of reference points on the template based on a previously established template. They are very rare in the modern methods, as they do not assure the necessary precision that depends, on one hand, on the correctness of establishing the correlation between the two template dimensions, and on the other hand, on the precision of obtaining the previous reference dimension.
The calculation relationships of type IV are used extremely rarely in the graphic calculation design methods where the sought value is defined as a constant numeric value.
The contours of basic templates are defined by the well-determined geometric procedures that involve the tracing of straight lines or curves. The exactness of generation of the curved contour determines the exactness of construction and the degree of dependence on the executor's qualification. The technology of tracing the curved contours in the construction and the compatibility of the method with the specialized design software, and implicitly, its actuality for the industrial design.

COMPARATIVE ANALYSIS OF METHODS OF DESIGNING TRICOT PRODUCTS

The process of elaborating the basic templates of tricot products to a significant extent depends on the tricot properties, especially its extensibility and production procedure.

This study has been focused on the jacket-type products for women, the tricot of extensibility degree I has been used (0-40%) owing to its compliance with the requirements of reliability of material and shape of finite product imposed on the jacket-type products. The external tricot products are characterized by laconic shapes, simplified cut, a reduced number of reference points.
Given the need to provide a good positioning of products on the body, that to a substantial extent depends on the quality of basic templates, it was decided to analyze a series of graphic calculation methods that are actually being used for elaborating the constructions of garments at the industrial scale. The study considered 10 design methods elaborated in 5 countries: Romania, Russia, Great Britain, Italy and Germany.

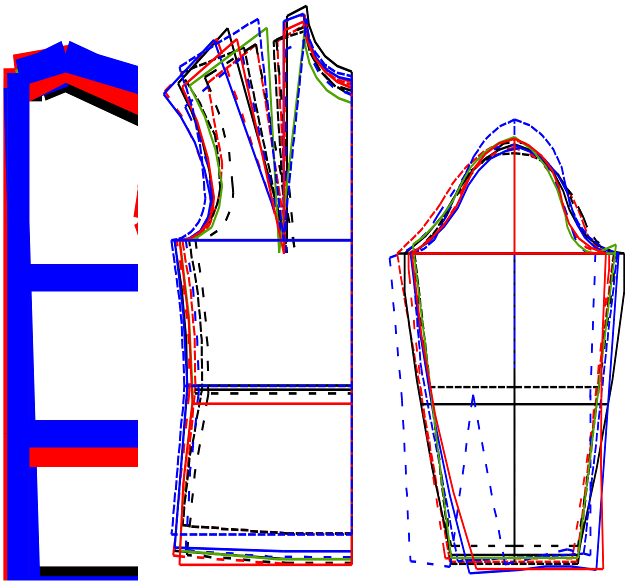

Figure 1: Comparative analysis by the superposition of basic template of a tricot jacket product, elaborated using the examined design methods [1-5]

Legend:

--------------	Italian method	————	Soviet method VDMTI[1]
-------------- (red)	Englis method	– – – – (red)	Russian method elaborated by the „Sretenka” Fashion House
_ _ _ _ _ _ _	Romanian method	———— (red)	Method of Kuznetova L. A.
_ _ _ _ _ _ _ (blue)	German method Müller & Sohn	———— (green)	Method of Konopaliteva N. M.
————	Soviet method LTILP[2]	-------------- (blue)	Method of Kolomeico G. L.

The considered methods are distinguished by the structure of used initial data, the number of anthropometric indicators varies between 17 and 26, thus determining the incidence of using the relationships of type I. Two of the analyzed methods use the dimensional parameters that take into consideration the morphological particularities of human body. The legerity add-ons are calculated depending on the properties of textile material, practically in all the considered design methods (except for the Italian and German methods), as this ensures the adequacy of the tricot construction.
The methods fit the templates into the network lines, so that the main horizontal lines are resumed to the cervical, axillary, waist and termination lines, while two of the methods impose the tracing of shoulder lines. The vertical lines delimit the width of neck cut, of back cut, sleeve cut at the product front, at the same time determining the position of bust center. As initial design axes were used the superior horizontal line and the front symmetry line – in 8 out of 10 examined methods.
The coordinates of constructive reference points on the template are determined using the relationships of types I and II, assuring the precision of construction, the curvilinear contours being represented by flowery lines, being determined by the position of a series of auxiliary points.
The differences of constructive order between the contours obtained by applying the basic template design algorithms have been established by their superposition, using as superposition axes the symmetry lines of back and front sides, and the bust line of the product, and for the sleeve reference element – the basic line of the sleeve head and its central axis (figure 1).

[1] VDMTI – method of designing garments elaborated by the Union’s Tricot Fashion House in Kiev, USSR.
[2] LTILP – method of designing garments elaborated by the Theoretical Institute of Light Industry of Leningrad (presently Sankt-Petersburg), USSR (presently Russian Federation).

The theoretical study of the selected design methods does not allow to determine the best one and to justify it for the design of jacket-type products. Therefore, it was decided to perform their qualitative analysis by manufacturing the models of products and checking the quality of their positioning on the mannequin. The standard body's initial anthropometric data was used: 164-92-100.
When testing the model, the equilibrium factor is determined, as a rule, by the positioning characteristics of certain segments of the product surface below the support elements and not by the positioning of equilibrium points of the support surfaces. The model testing has been performed in several stages.
The first stage included the evaluation of special-volumetric shape of products at the level of support surfaces assured by the respective depth of wedges or by respective heat and humidity treatment. At the next stage of model checking the position of product on the body in other zones has been performed, with evaluation of equilibrium on shoulders and at sides. The third stage of model testing included the balancing of product at the shoulder and lateral levels that depends on the value of back-and-front equilibrium. So, we have determined the zones of the product that have deficiencies of positioning on the body and have identified the principles of designing the templates providing for a high quality of product positioning on the body. These results have been used as a basis for the elaboration of an optimized algorithm of body unfolds adapted to the properties of the basic material and the requirements to a particular type of product.

CONCLUSIONS

The emergence of new materials for the manufacturing of garments requires improvements to the methods of designing the basic constructions. As the tricot industry is rapidly developing new types of materials with different properties, they are often used for manufacturing products of various types and destinations, including classical products that traditionally are characterized by rigid, laconic and smooth shapes. In this context the adequate choice of procedures for elaborating the basic templates determines the quality of product positioning on the human body. The graphic calculation methods are the most widely spread ones in the context of industrial design of garments, as they allow to obtain plane contours of unfold body shapes with sufficiently exact approximation, as well as to use the contemporary computer-aided design technologies. The problem of choosing the optimum algorithm for the elaboration of basic templates can be easily resolved based on the analysis of defining components for the particular group of design methods.

REFERENCES

[89] Алдрич, У.: *Женская одежда. Английский метод конструирования и моделирования,* Издательский дом Эдипресс-Конлига, Москва, (2008)
[90] Cretu, M.: *Proiectarea si tehnologia confectiilor din tricoturi*, Editura „Gh. Asachi", Iasi, (2000)
[91] Конопальцева, Н.М. и др.: *Конструирование и технология изготовления одежды из различных материалов. В 2-х частях. Часть 1. Конструирование одежды,* Издательский центр «Академия», Москва, (2007)
[92] Методические рекомендации по конструированию женских жакетов из трикотажных полотен. Москва ЦНИИТЭИлегпром, (1984), 124 с
[93] Тухбатуллина, Л.М.: *Конструирование женской одежды по европейским методикам*, Издательство Феникс, Ростов-на-Дону, (2009)

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