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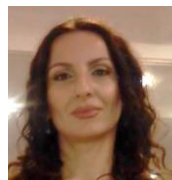
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**SECTION 25. Technologies of materials for the
light and textile industry.**

OPTIMIZING THE STYLE AND CONSTRUCTIONAL PARAMETERS OF WOMEN FOOTWEAR

Abstract: In the article the issue of optimizing the style and constructional parameters of women footwear is discussed. This is especially important for the women, because the problem of selecting the comfortable footwear is more acute for the age group of women than for other groups, because there are more variations of footwear types produced for that group, especially according the height of the heel and the style (shape of the shoe toe) of shoes.

Key words: evolution of footwear; comfort characteristics of the footwear; national fashion.

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Introduction

The comfort characteristics of the footwear is directly dependent on the shape of the toe, height and shape of the heel. Especially, when we deal with the shoe of the narrow toe, also high and narrow heel footwear, exploitation of it is the risk-factor of the consumptional discomfort along with visual harmony.

The problem of selecting the comfortable footwear is more acute for the age group of women than for other groups, because there are more variations of footwear types produced for that group, especially according the height of the heel and the style (shape of the shoe toe) of shoes (table 1).

Thus, when the issue is to satisfy women age group with comfortable footwear, the relevance of the outward appearance and consumptional parameters of the shoes remains the main problem.

From all the possible options of dispersion of footwear styles the mode of the distribution was taken, which covered the typical clusters of the shapes.

Materials and Methods

It is known, that all the shapes of the shoe style effects the feet comfortableness in its own way. The

foot comfortableness is also effected by the placement of the front foot-phalanges in the footwear freely and in a convenient way, which by itself conditions the comfortable movement in the moment of performing the complete cycle of stepping, as well as the restricts the stretch of the leg in a longitudinal direction and etc. On the other side, the change in the height of the heel causes increase of the pressure in the beam part of the foot (metatarsal) conditioned by the weight of the body (fig. 1), and reducing the wideness of the heel shape – reduction of the area of pressure distribution of this support surface. This respectively causes more effort from the consumer (fig. 2) for maintaining the balance during the walking and standing and tense condition of the whole body.

Therefore, the crucial condition for producing comfortable footwear, besides the optimal size-width assortment, is the convenience of the support surface and different cuttings of the footwear. For example, the shape of the toe part of the shoe, the optimal selection of which has a great importance in convenient placement of the foot in beam part (metatarsal), relaxation and ease of the movement.

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Table 1.

The variations of shape of toe, height and shape of the heel.

C	Shape of toe Length of toe	1	2	3
		Narrow	Average	Wide
1	Triangular long			
2	Oval long			
3	Triangular average			
4	Oval Average			
5	Trapezium average			
6	Oval short			
7	Trapezium short			

Shape of heel Height of heel	1	2	3	4
	Wedge shape	Wide	Average	Narrow/thin
Flat (0-3 mm)				
Low heeled (3-25 mm)				
Medium heeled (30-45 mm)				
High heeled (50-70 mm)				
Especially high heeled (more than 70 mm-)				

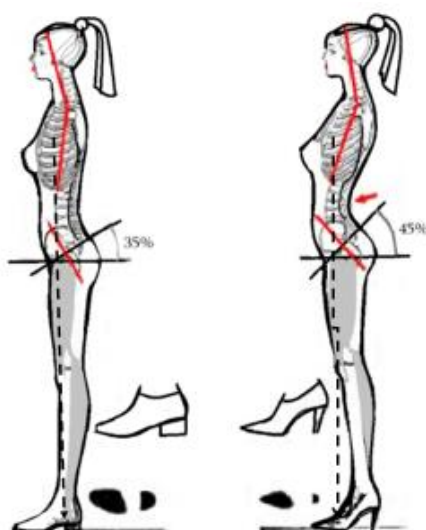


Fig. 1. The moving over of the center of gravity by the change in the height of the heel.

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The analysis of the ethno footwear construction ensures us, that historically the shape of the footwear toe was a special consideration for people [1, 2]. The twisted shape of the toe along the longitudinal axis,

so called “curling”, dominating for a long time, as it seems acquired its consumptional function and survived the centuries.

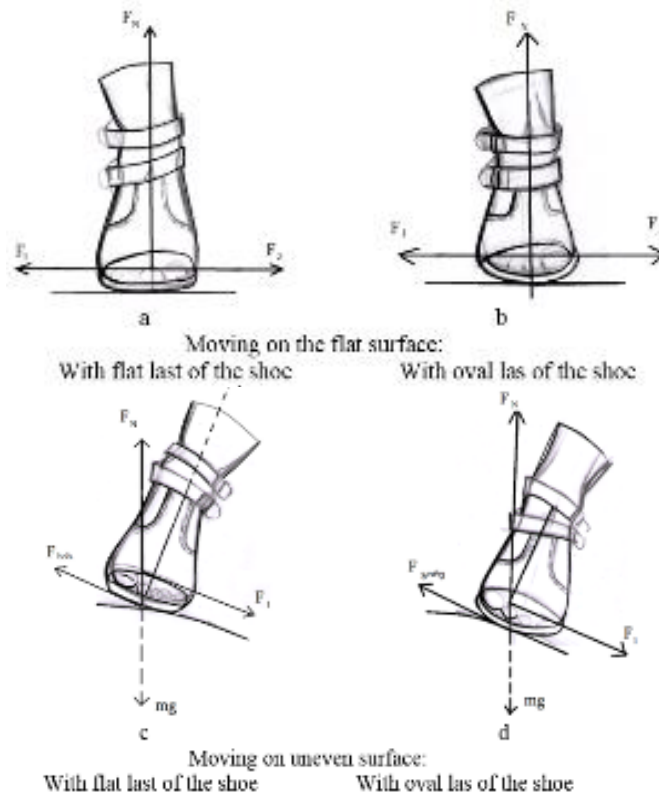


Fig. 2. Forces affecting the foot in static depending on the type of the support surface.

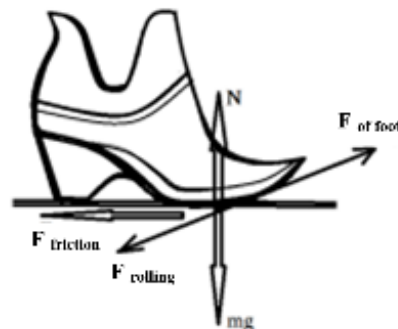


Fig. 3. The last with rolling feature and forces affecting it.

For working out the optimal construction of the modern footwear the following system of forces that effect the shoe and foot in statics and dynamics, respectively, was analysed (fig. 3):

□ In statics the normal pressure affects the body from the supporting, which balances the center of gravity. The more the weight of the body, higher the force. Shorter the heel, more the center of forces affecting the support is moved to the direction of the heel. And in opposite, higher the heel, more it moves to the front phalange of the foot to toes (fig. 1). As a result, the walking surface (depending on its rigidity) as well as the footwear itself experience the

deformations (the center of deformation is dependent on the size of the center of gravity movement);

□ Forces of friction, the overcome of which is dependent on the material of the last and supporting surface and the degree of surface processing;

□ In case of humid weather –force of wet friction, which is much more less than force of dry friction;

□ The rigidness of materials, which are situated between the foot and the supporting surface, so the package of bottom materials – rigidness of the welt, vault, filler, platform (in case of existence) and

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last. Although the lightness and elasticity of this material reduces the forces generated while walking and the energy spent on it, at the same time it reduces the stability and durability of the shoes.

For comfortableness of the footwear the analysis of the complete cycle of stepping was made,

which consists of several phases (fig 4). The fluence of stepping and the maximal comfortableness of the body is ensured when this cycle flows without excess loads [3-8]. The responsibility of it is borne by the footwear.

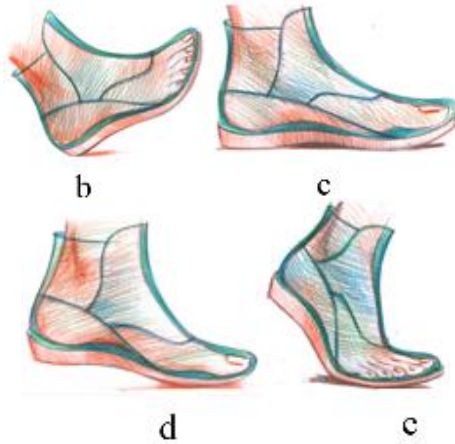


Fig. 4. Structure of walking

Because the forces different in direction and strength effects the different points of footwear during the movement, the load transferred to the foot by them is different, respectively. It was confirmed by the researches, that 88.9% of the population spends the most of its time with tensed condition of the feet. According to the research held by scientists of Stanford university a human makes 4,961 steps daily in average [9]. Even a small decrease in the load of this work can give us an opportunity to save a significant amount of energy during the day.

Historically, the dominant round shape of the shoe toe along the longitudinal axis conditions the formation of rolling friction forces (fig. 2), the absolute value of which is dependent on the rigidity of the surface and rolling object, also on the radius of the object and this force is significantly smaller than the friction force, especially in dry conditions. The deformations formatted on the rolling object and the support during walking can be reduced by using the rigid materials.

For constructing the optimal shape of the footwear toe the laws of mechanics and three-dimensional projecting methods was used, with help of which the construction of the last was worked out which then became the bases for production of the modern ethno footwear.

Also was analyzed of deformation issued of materials in the process of footwear exploitation, because the deformations caused by affecting, multiply repeating loads conditions the reduction of the shape-durability of shoes. As the result is loses visual-aesthetic image, shape, its durability and exploitation period is reduced, respectively. Also

discusses about the results of affecting bending and compression forces on the footwear and its impact on the shape durability of it.

Therefore, the new issue has been raised – search for the ways for minimizing that forces, so work out such a construction, which excludes such forces in the system of “foot-footwear” in case of using the same materials.

The forces affecting the footwear and the foot, in it is discussed in table 2, also the factors which conditions the reduction of the impact of this forces. The table also represents the positive and negative influence of them on the consumer features of the footwear.

Conclusion

The research gave us the possibility to justify the high effectiveness of the last constructed by us from the point of view of saving the energy daily by the human during the movement. Using the relevant calculations and three-dimensional modelling and based on the dynamic analysis of constructional mockup of the last the optimal shape, radius of toe bending, the width of the beam part (of metatarsal) of the shoes and the height of the heel was worked out. For this purpose, the relevant mockup of the last was constructed in advance by us (fig. 5).

Based on the analysis of discussed dominant, regular factors of the ethno footwear the collection of the women ethno footwear was created, their constructional bases (prime-models) were projected on the ready last and was realized in materials (fig. 6).

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Table 2.

The forces affecting the footwear and foot in it.

Forces affecting the shoe and the foot	Ways of reducing tension	Negative side	Positive side	Note
Force of friction	Smooth surface of the last	Non-stability to slipping		
	Last construction with rolling feature		Little value of rolling friction force compared to dry friction force	Acceptable
Force of gravity of the body	Inevitable factor			
Elasticity force of the support	Inevitable factor			
Rigidity of the last	Use of light and elastic (polymeric) materials	<ul style="list-style-type: none"> • Increase in thickness of the last compared to natural materials • Less durability against wearing out • Low visual effect 	<ul style="list-style-type: none"> • Lightness of the shoes • Elasticity 	Acceptable (not for classic footwear)
Rigidity of the welt	Decrease the thickness	Decrease of durability of footwear (because of high risk of breaking down the welt)		Not acceptable
Rigidity of filling (platform)	Use a light, elastic, natural fiber		<ul style="list-style-type: none"> • Lightness • Little deformation of bending • Durability • Convenience during exploitation • cheapness 	Acceptable



Fig. 5. Pictures reflecting the 3D projection process of shaping the toe of the last and the final mockup of it.

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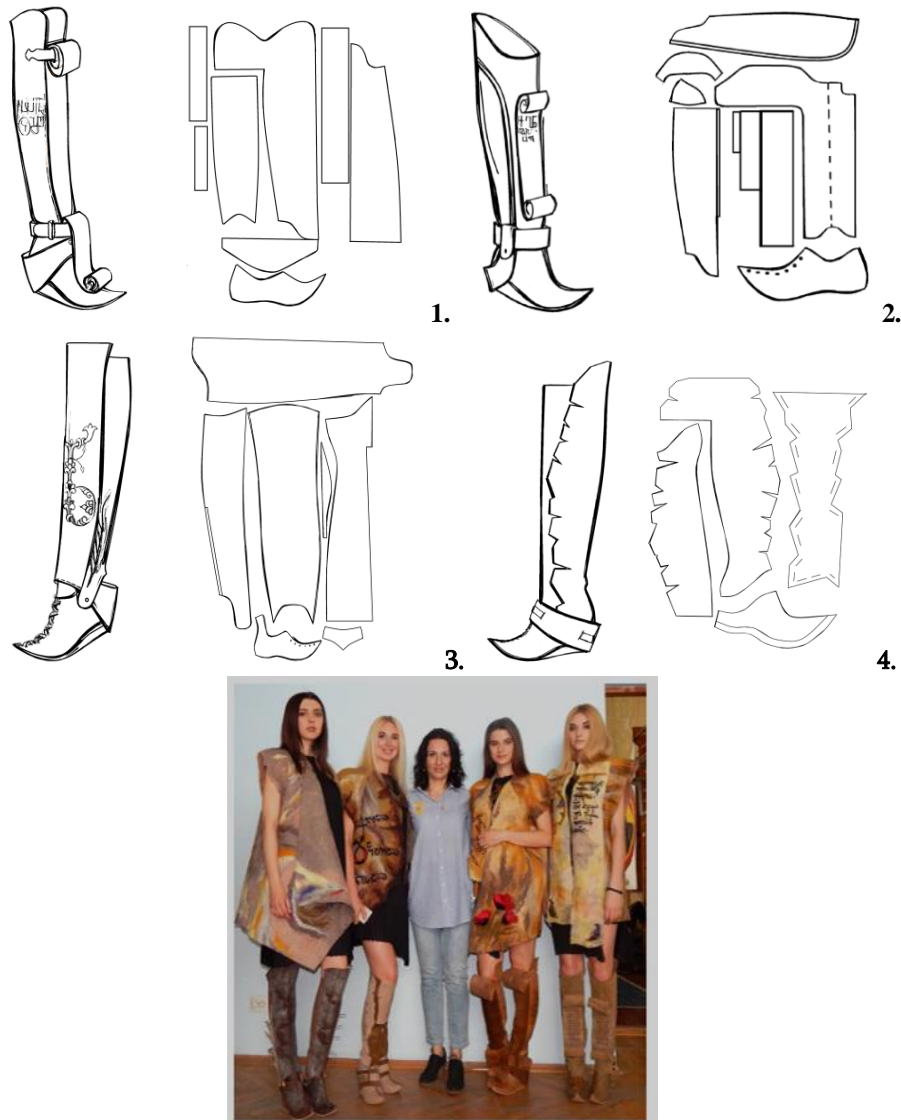


Fig. 6. Sketches and constructions of shoes created on the ethno motives, and fragments from its public demonstration.

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