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DIVERSIFICATION OF A SAFETY FOOTWEAR PRODUCT

HARNAGEA Marta Cătălina[1], SECAN Cristina[2]

[1]WIZWEDGE, 114 Boulevard Camille Flammarion, 13004, Marseille, France, E-Mail: martaharnagea@yahoo.com

[2] University of Oradea, Faculty of Energy Engineering, Department of Textiles-Leather and Industrial Management, B.St.Delavrancea str., No. 4, 410087, Oradea, Romania, E-Mail: cris_secan@yahoo.com

Corresponding author: HARNAGEA Marta Cătălina, E-mail: martaharnagea@yahoo.com

Abstract: *Product diversification is a usual strategy of footwear producers. As a requirement related to competitiveness in this domain, diversification can be done by practical application of some criteria. Considering this aspect, the paper proposes a research on the diversification in the case of a safety footwear product by modifying its component patterns, while keeping the initial shape of the product. Thus, starting from a safety shoe model, diversification was performed by changing the configuration in the joining area of two patterns of the product.*
By joining the tongue with the bellows tongue, the upper with the quarter, the heel counter with the quarter and the collar and heel counter with quarter has resulted a family of models characterized by a reduction of the number of patterns in the product. The size of the set presents a significant influence on the theoretical nesting factor and implicitly on the size of the wastes. The analysis of the resulting new model types lead to highlighting the influence of the patterns number of the uppers and the area of the set on the usage index of the leather surface when cutting the parts and on the specific consumption.

Key words: *manufacturing, footwear, nesting factor, waste, usage index, specific consumption*

1. INTRODUCTION

In the process of footwear manufacturing the improved use of materials has a great significance on the manufacture price decrease.

From an organizational and economical point of view, the diversification of a footwear collection involves a series of possible problems as it implies the repetition of major activities whenever the model changes at a certain step. Some of them (such as product design and making of the afferent cutting devices) are time-consuming and expensive, especially when carried out by classical means and methods [1].

As a result, in footwear design, automated systems such as CAD systems (computer aided design) are being used as they allow an automatic control of this activity, the footwear design being conjugated with certain activities such as CAM (computer aided manufacturing) [2].

The precision of execution for the basic designs, the cutting patterns, the accuracy of grading for obtaining the whole size range of patterns are just some of the advantages that design systems available on the market can offer to footwear designers.

Considering these aspects a safety shoe model was designed in AutoCAD software and a family of models was furthermore developed by changing the configuration in the joining area of some patterns. [2]. The family of models so constituted, decreases the number of patterns and implicitly the specific consumptions during cutting of parts on leather surface.

2. PRESENTATION AND DESIGN OF THE BASIC MODEL

The basic model was taken from a footwear company and designed in AutoCad pattern making software.

Model information

Safety shoe
Size range: 36-48
Materiales: uppers – natural box leather
lining - 3D knit
Individual Sole
Construction : tubular and cemented

Starting from the mean forme of the shoe last the basic drawing was made, considering the design particularities of the model [2, 3], figure 1.

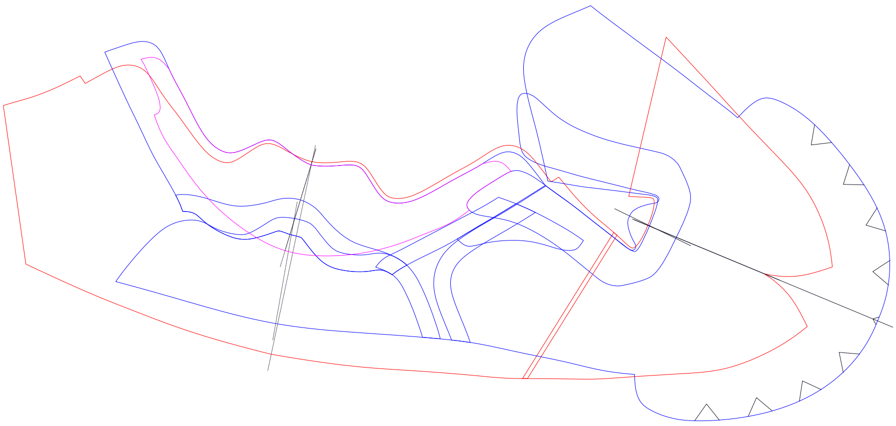
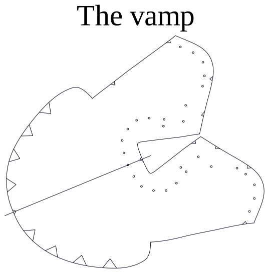
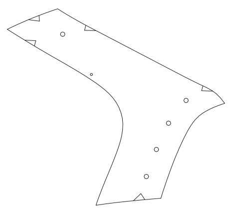
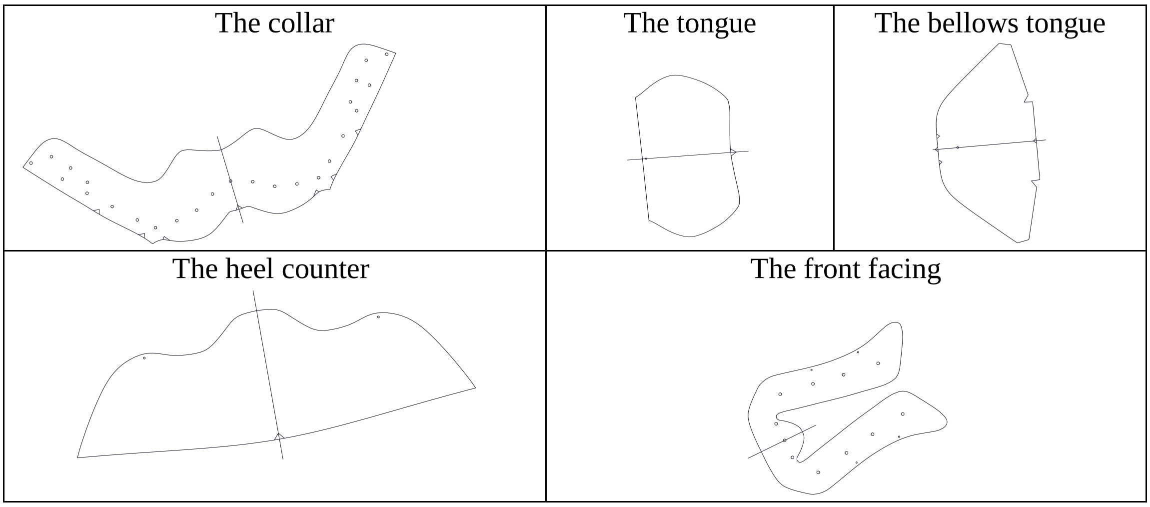


Fig. 1: *The master pattern of the uppers*

The structure of the outer subassembly (product uppers) are illustrated in table 1.

Table 1*: The outer patterns of the model*

The patterns of the outer subassembly	
The vamp	The quarter
	



3. THEORETICAL CALCULATION OF LEATHER CONSUMPTION FOR THE BASIC MODEL

In table 2 are presented the values of the nesting factors for each pattern of the footwear product as well as the average nesting factor [4].

Table 2: *Nesting factor of component patterns*

No.	Pattern name	Nr. of similar patterns in set	Area(dm^2)		Area of the parallelogram (dm^2)		Perimeter (dm)		Nesting factor (Fa) (%)
			Pattern	Similar pattern	Pattern	Similar pattern	Pattern	Similar pattern	
1	vamp	2	4.072	8.144	4.466	8.932	10.16	20.32	91.18(%)
2	quarter	4	0.281	1.124	0.327	1.308	2.98	11.92	85.93(%)
3	heel counter	2	0.857	1.714	0.928	1.856	4.48	8.96	92.35(%)
4	collar	2	1.192	2.384	1.433	2.866	6.83	13.66	83.18(%)
5	front facing	2	0.668	1.336	0.875	1.75	5.94	11.88	76.34(%)
6	bellows tongue	2	1.576	3.152	1.622	3.244	5.31	10.62	97.16(%)
7	tongue	2	0.501	1.002	0.522	1.044	2.81	5.62	95.98(%)
Total		ns= 16		As= 18.86		Aps= 21.00		Ps= 82.98	
$\overline{F_A} = \frac{A_s}{A_{ps}} \cdot 100 = \frac{18.86}{21} \cdot 100 = 89.81\%$									

For a clearer vue of how the calculation is done, table 3 shows the elements and relations for determining the specific consumption for the basic model [4, 5].

Table 3: *Elements and relations calculus for establishing the specific consumption [6]*

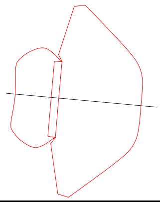
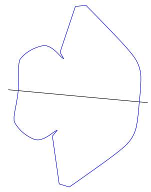
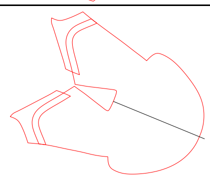
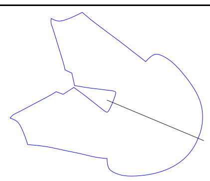
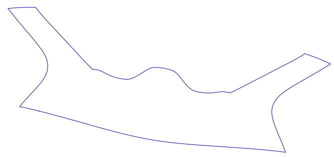
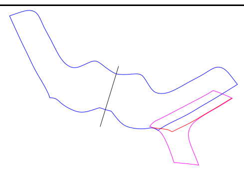
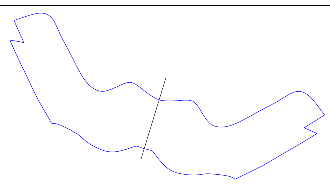
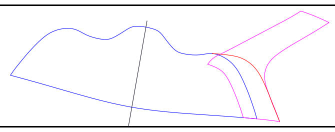
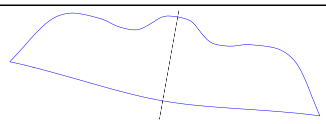
Element, significance	Calcul formula	Measuring units	Value
n, number of patterns			16
A_s, pattern's surface area		dm^2	18.86
$A_{ps,}$ area sum of parallelograms that include the set patterns		dm^2	21.00
$\overline{F_A}$, nesting factor	$\overline{F_a} = \frac{\sum A_r}{\sum A_p} = \frac{A_s}{A_{ps}} \cdot 100$	%	89,81
a_{Dn} , normal wastes area	$a_{DN} = 100 - \overline{F_A}$	%	10,19
$\overline{A_S}$, sum of set's areas	$\overline{A}_S = \frac{A_S}{n}$	dm^2	1.18
$\overline{A_p}$, area of leather		dm^2	160
f_a , area factor	$f_A = \frac{\overline{A_p}}{\overline{A_S}}$		135.59
a, coefficient for flexible leathers			39
$\sqrt[4]{f_A}$, area factor			3.41
a_{Dm+Dt} , area of marginal and patterns wastes	$a_{Dm+Dt} = \frac{a}{\sqrt[4]{f_A}}$	%	11.43
P_s, set perimeter		dm	82.92
p, width of the between patterns		dm	0,02
a_{Dp} , area of wastes between patterns	$a_{Dp} = \frac{p \cdot P_S}{2 \cdot A_S} \cdot 100$	%	4.32
a_{DT} , total wastes area	$a_{DT} = a_{Dn} + a_{Dp} + a_{Dm+DT}$	%	25.94
I_U , leather utilization index	$100 - a_{DT} = 100 - (a_{Dn} + a_{Dm+t} + a_{Dp})$	%	74.06
C_S , specific consumption	$C_S = \frac{A_S}{I_U} \cdot I_C \cdot 100$; Ic=1	dm^2	25.46

4. ANALYSIS OF THE NEW TYPES OF MODELS

The family of models was obtained by creating distinctive types of models through changing the configuration in the joining area of two patterns.

With this regard, the different types of model were established by joining the tongue with the bellows tongue, the heel counter with the quarter and the collar + the heel counter with quarter; the configuration of modified patterns is shown in table 4.

Table 4: *Modifying the patterns for obtaining new models*

Model types	Initial joining of the patterns	Modified joining of patterns
Model M1 joining the tongue with the bellows tongue		
Model M2 joining the vamp with the quarter		
Model M3 joining the heel counter with the quarter		
Model M4 extending the collar and the heel counter, by including the quarter		
		

In table 5 is presented the comparative analysis of the new proposed models.

Table 5: *The wastes values, usage indices on the surface of the leather and of the consumption norms*

	U.M	Mb	M1	M2	M3	M4
ns		16	14	12	12	12
As	dm^2	18.86	18.72	18.43	18.63	18.36
Aps	dm^2	21.00	21.77	20.48	21.24	20.99
Ps	dm^2	81.44	79.28	73.42	77.48	73.36
$\overline{F_A}$	%	89.81	86.19	89.99	87.71	87.47
Dn	%	10.19	13.81	10.01	12.29	12.53
Dm+t	%	11.43	11.78	12.20	12.22	12.18
Dp	%	4.32	4.24	3.98	4.16	4.00
D_T	%	25.94	29.83	26.19	28.69	28.71
I_U	%	74.06	70.17	73.81	71.31	71.29
C_S	dm^2/pair	25.46	26.68	24.97	26.12	25.76

Analyzing the values obtained we notice a reduction of the number of patterns from the set and thus implicitly the set area.

In the new family of models, the usage index of leather when cutting the upper patterns varies in function of the selected model, being influenced by the configuration of the patterns and the set size.

Marginal and printing wastes increase by reducing the number of patterns from the product composition, when using the leather with a constant surface area (160dm^2). On the other hand, the waste is reduced by reducing the number of patterns of the set.

5. CONCLUSIONS

Nowadays it is a must for shoe manufacturers to pre determine the consumption of materials required for a particular design and to control the consumption of material. So, it is necessary to calculate the amount of material required in the case of diversification. By changing the configuration of patterns in the joining area, by adding a pattern to another pattern respectively, the reference set size is decreased, having a significant influence exerted on the size of normal marginal waste, between patterns and by bridges.

The best option in terms of specific consumption is M2 model type or the version in which the quarter was joined with the vamp.

The modification of the upper resulted in a consumption norm of 24.97 dm^2 / pair. Compared to the basic model we achieved a reduction of standard consumption with the 0.49 dm^2 / pair.

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