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THE OPTIMIZATION OF THE SHOE UPPER PATTERNS

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Abstract: The design process implies following the esthetical and functional criteria in order to use the materials as rational as possible. Also it is taken into consideration the optimization of the pattern's configuration as it is important from the economical point of view. There will be chosen a nesting system that allows the maximum utilization of the material surface (the optimal nesting of the pieces so that both good quality parts and the lowest waste amount could be obtained). This paper presents illustrates the effect of the shoe uppers configuration on the nesting factor and implicitly on the specific consumptions when cutting the leather surface.

1. INTRODUCTION

The footwear components are different as shape and area, these characteristics of the patterns are elements that determine the particularities of a model for a certain footwear product.

In the design process, the pattern's shape will be conceived in such a way that they respond to the esthetical and functional criteria that are required for the products, in order to use as rational as possible the materials.

In the design process the optimization of the pattern's configuration is important from the economical point of view.

Thus, when designing the footwear component parts, a nesting system that allows the maximum utilization of the material surface (the optimal nesting of the pieces so that both good quality parts and the lowest waste amount could be obtained) will be chosen.

The part's contour and the chosen nesting have a significant influence not only upon the nesting factor but as well upon the normal wastes (the amount of the wastes issued from the curved configuration of the similar parts, D_n).

In this paper there is presented the result of the research concerning the effect of the footwear uppers configuration on the nesting factor and implicitly on the specific consumptions during cutting on leather surface.

2. THE MEDIUM NESTING FACTOR- ECONOMICAL INDICATOR OF DESIGN ANALYSIS

The amount of the wastes issued from the curved configuration of the similar parts (D_n) is determined considering the theoretical nesting models. After establishing the methods of nesting for each single pattern there is obtained the nesting factor as a proportion between the area of the patterns included in parallelogram and the area of the parallelogram that includes similar patterns.

The nesting factor of each pattern was calculated using the following relation:

$$F_a = \frac{n_s \cdot A_r}{A_p} \cdot 100 \quad (1)$$

where:

A_r - pattern's surface area, in dm^2;

n_s - number of similar patterns included in parallelogram.

The average nesting factor was calculated using the relation:

$$\overline{F_a} = \frac{A_{set}}{A_{paralelogram}} \cdot 100 \text{, [\%]} \quad (2)$$

Where:

A_{set} – sum of patterns area;

$A_{paralelogram}$ – area sum of parallelograms that include the patterns.

As the average nesting factor is higher the normal wastes resulted when cutting are smaller. The design of models with a high nesting factor allows a significant decrease of the normal wastes.

In order to calculate all types of wastes (D_n, D_t, D_m, and D_p), the following relations were used:

$$A_{Dn} = A_{PS} - A_S \text{, [dm}^2\text{]; } a_{PN} = \frac{A_{Dn}}{A_S} \cdot 100 \text{, [\%]} \quad (3)$$

$$A_{Dp} = P_S \cdot \frac{p}{2} \text{, [dm}^2\text{]; } a_{Pp} = \frac{A_{Dp}}{A_S} \cdot 100 \text{, [\%]} \quad (4)$$

$$D_{Dm+t} = \frac{a_{Dm+t}}{100} \cdot A_S \text{, [dm}^2\text{]; } a_{Dm+t} = \frac{a}{\sqrt[4]{f_A}} \text{, [\%]} \quad (5)$$

Where:

A_{ps} – set parallelogram area;

P_s – set perimeter;

p – width of the between pattern;

a = 39, for flexible leathers;

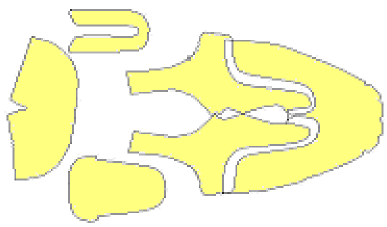
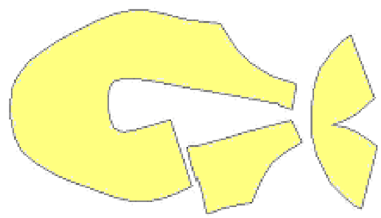
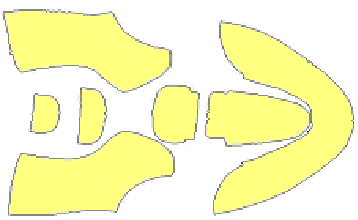
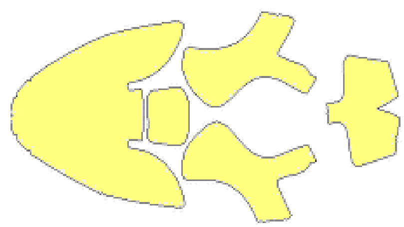
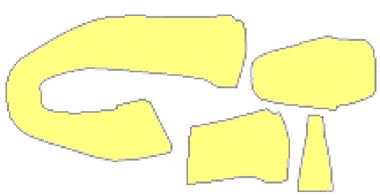
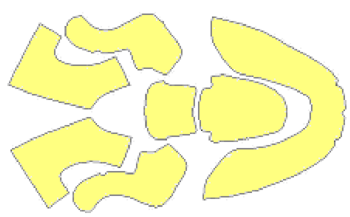
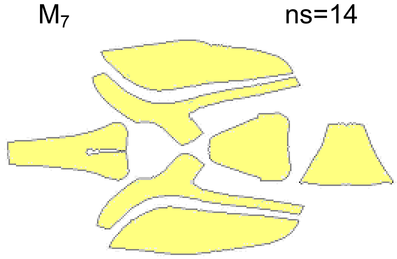
f_A – area factor as a ratio between the average area of leather surface and the average area of set surface.

3.CASE STUDY

In order to achieve results for this study there have been designed seven footwear products. The models vary as shape, surface and the number of patterns that are part of the footwear product.

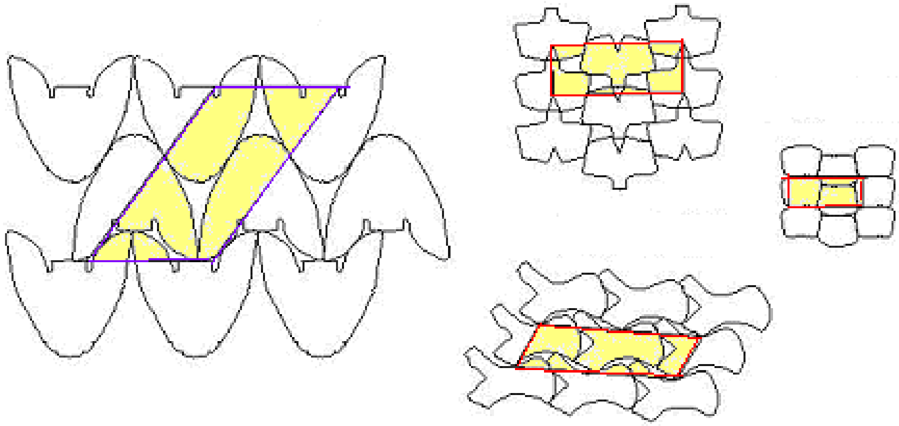
The configuration of the patterns is ilustrated in table 1.

Table 1. Model's configuration

Component part configuration	
M_1 ns=12 	M_2 ns=6 
M_3 ns=16  M_2	M_4 ns=10 
M_5 ns=8 	M_6 ns=14 
M_7 ns=14 	

Using AutoCad 2006 software, for each component part of some shoe models, nests with parallelogram shape were done as to calculate the nesting factor.

As an example, figure 1 presents the nesting in parallelogram for each component part – V_4 variant of model.



Fiure 1. Nesting in parallelogram –M_4 pattern variant

Table 2 presents the values for the average nesting factor, the D_n, D_t, D_m, and D_p wastes as well as the area of the total wastes (corresponding to a leather surface of 132dm^2).

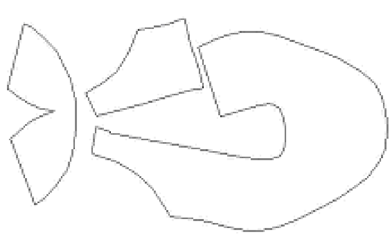
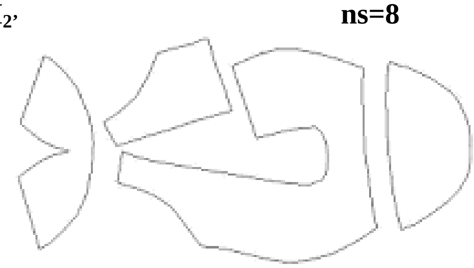
Table 2. The average nesting facto and the waste values

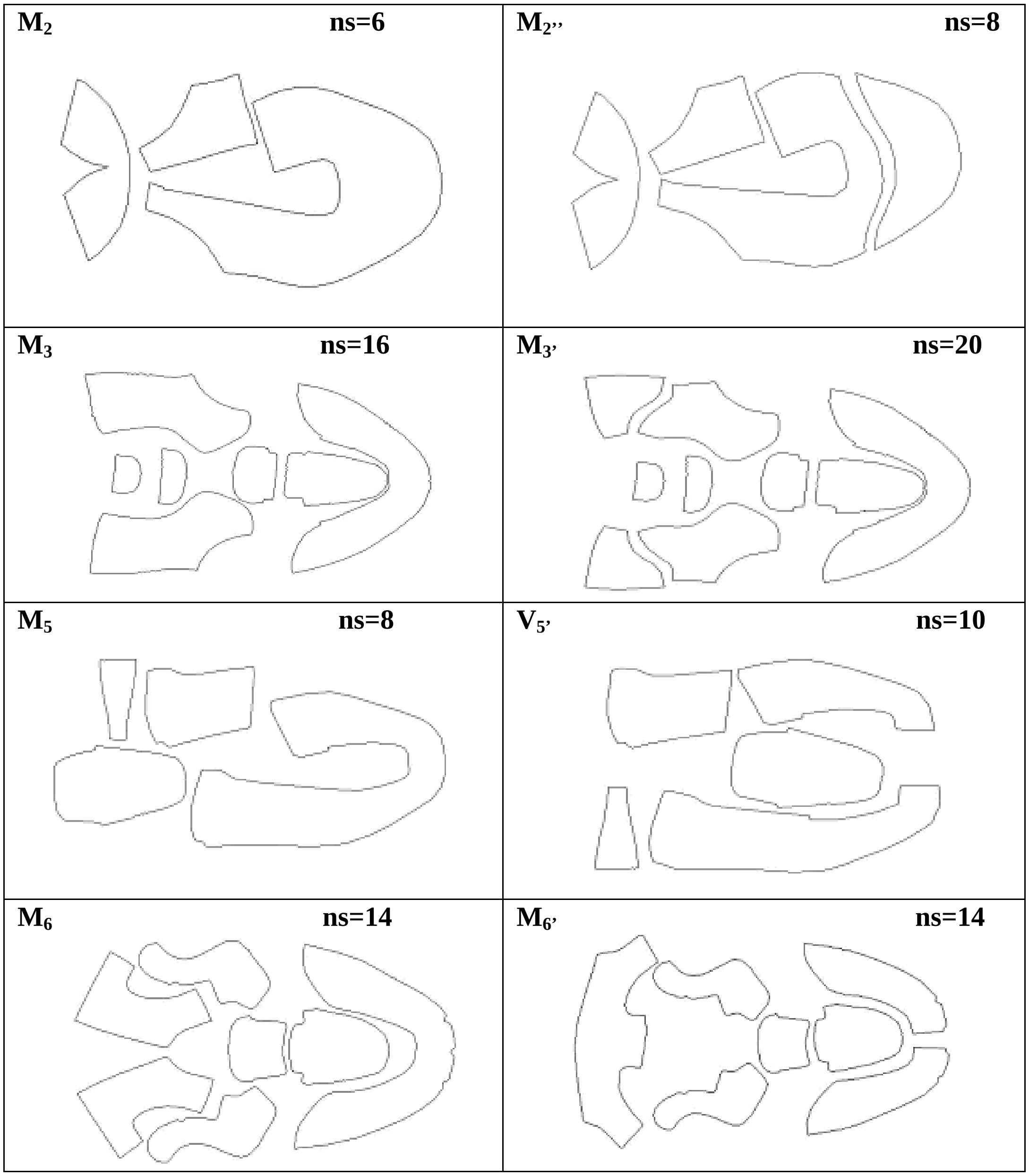
Model	n_s	A_s dm^2	$\overline{F_A}$ %	D_n area		D_t area		D_m area		Total waste area	
				[dm^2]	[%]	[dm^2]	[%]	[dm^2]	[%]	[dm^2]	[%]
M_1	12	13.4100	81.97	2.9487	21.9800	0.6496	4.8430	1.5073	11.7096	5.1056	38.5326
M_2	6	8.4752	82.57	1.7888	21.1062	0.3528	4.1627	1.0631	12.5438	3.2047	37.8127
M_3	16	14.6688	83.33	2.9337	19.9900	0.6736	4.5920	1.6582	11.3043	5.2655	35.8843
M_4	10	14.2878	85.03	2.5152	17.6038	0.5566	3.8956	1.7973	12.5794	4.8691	34.0788
M_5	8	9.7504	80.17	2.4114	24.7313	0.4262	4.3711	1.1787	12.0896	4.0163	41.1920
M_6	14	16.4346	80.91	3,8788	23.6014	0.7378	4.4893	1.9683	11.9767	6.8490	40.0674
M_7	14	12.866	82.43	2.7421	21.312	0.6352	4.9370	1.2836	11.3395	4.6609	37.5885

The values of the average nesting factor, obtained for the 7models vary between 80,17(M_5) si 85.03%(M_4).

Variants of model M_2, M_3, M_5 and M_6 have been modified through cutting the vamp or the quarter**,** table 3.

Table 3. The variation of the model's configuration

Initial model	**Modified model**
M_2 **ns=6** 	**$M_{2'}$** **ns=8** 



For the modfied variants of model there are presented the values of the average nesting factor, the D_n, D_t, D_m, and D_p wastes as well as the area of the total wastes (corresponding to a leather surface of 132dm^2).

Table 4. The modified variants

Model	n_s	A_s dm^2	$\overline{F_A}$ %	D_n area [dm^2]	D_n area [%]	D_t area [dm^2]	D_t area [%]	D_m area [dm^2]	D_m area [%]	Total waste area [dm^2]	Total waste area [%]
$M_{2'}$	8	8.5068	85.89	1.3973	16.4256	0.4152	4.8808	1.0327	11.7739	2.8452	33.0803
$M_{2''}$	8	18.5028	87.52	1.2114	14.247	0.4276	5.0289	1.011	11.8906	2.6500	31.1665
$M_{3'}$	20	15.0144	85.03	2.6429	17.6024	0.7524	4.9827	1.6483	10.9164	2.04364	33.5015
$M_{5'}$	10	9.6382	89.03	1.1871	12.3166	0.4436	4.6025	1.0892	11.3013	2.7199	28.2204
$M_{6'}$	14	16.5688	84.83	2.9619	17.8763	0.728	4.5817	1.8399	11.8181	5.5298	34.3704

Through modification of the initial configuration there have resulted better values for the average nesting factor, respectively 84,83........89.03%.

4.CONCLUSION

For the seven variants there have resulted different values of the average nesting factor, respectively between 80,17 and 85,03%.

The smallest value of the average nesting factor, 80,17%, has been obtained for the variant V_5 (n_s=8) and the highest value (85,03%) for V_4 (n_s=10).

Through modification of the pattern's configuration for the models V_2, V_3, V_5 şi V_6, respectively cutting the vamp or the quarter there has resulted an increase of the average nesting factor.

For the model V_2 there have been obtained two versions of the toe cap. Thus for both models ($V_{2'}$ and $V_{2''}$) higher values of the average nesting factor have been obtained in comparison to the base variant; $V_{2''}$ version with an average nesting factor of 87,52% higher than $V_{2'}$ variant, 85.89%.

The optimum variant, respectively with the highest value of the average nesting factor (89,03%) is for the $V_{5'}$ version. In this case the section of the strap from the median area has conveyed to better nesting in parallelogram for the two obtained patterns.

A right choice of the nesting variant may conclude to a rise of the average nesting factor and that will lead to a diminuishing of the normal wastes.

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