ACTA FACULTATIS XYLOLOGIAE ZVOLEN, 60(1): 121−127, 2018
Zvolen, Technická univerzita vo Zvolene
DOI: 10.17423/afx.2018.60.1.13

THE USE OF WOOD VENEER FOR LASER ENGRAVING PRODUCTION

Mikhail Chernykh – Evgeniia Kargashina – Vladimir Stollmann

ABSTRACT

Laser engraving on veneer with the texture used as the pattern part is investigated in this paper. The investigation was carried out on the veneer of radial and tangent cuts of wood species used for laser engraving – beech (*Fagus sylvatica*), pine (*Pinus sylvestris*), chestnut (*Aesculus hippocastanum*), mahogany (*Swietenia macrophylla*) and sapele (*Sapelli*). The accepted engraving modes eliminated veneer burning-out and provided readability of fine elements of the patterns. The aesthetic perception of the engravings produced by the laser was evaluated by the experts; the influence of the pattern contrast with the background and its formula on the aesthetic perception was demonstrated. The best aesthetic perception is achieved on light wood species having high contrast between the pattern and background.

Key words: wood, veneer, texture, laser, engraving, contrast.

INTRODUCTION

The texture of a number of natural materials – birch bark, wood and stone – is successfully used as pattern elements produced on them. Depending on the material type, different techniques are applied to produce patterns – painting on birch bark, wood and stone (SURIN 2017, GERASIMOV 2017, ANONYMOUS 2017, SHAFRANOVA 2017), pyrography and laser engraving on wood (BENDER *et al*. 2017, ANONYMOUS 2015, PETRU 2015, PANZER 1998), embossing on wood, birch bark and veneer (Fig. 1).

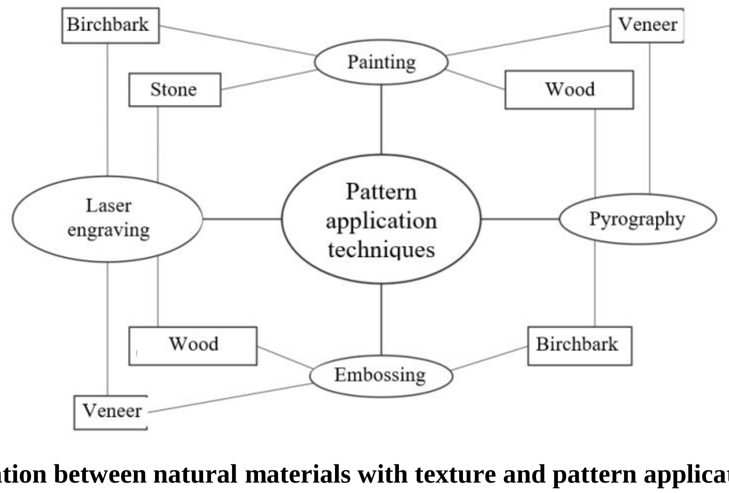


Fig. 1 Interrelation between natural materials with texture and pattern application techniques.

Manual pyrography on wood allows producing unique and inimitable drawings (BENDER *et al*. 2017), but it is inefficient and the item price is very high.

Wood laser engraving eliminates the manual work, drastically increases the efficiency and allows automating the technological process. The engraving is performed on boards – one-piece or laminated. It is rather difficult and expensive to find one-piece boards with suitable texture, especially those of valuable wood species. But it is even more complicated to find the texture pattern of laminated boards, since the board laminated parts have different textures and their joint spots often spoil the plot composition and decrease aesthetic value of the items (KACIK – KUBOVSKY 2011, VIDHOLDOVA *et al*. 2017).

It is proposed to perform laser engraving on veneer glued to the base. It is easier to select the required texture pattern, the material losses go down, as well the item price.

MATERIALS AND METHODS

The investigation was carried out on the veneer of radial and tangent cuts of wood species used for laser engraving – beech (*Fagus sylvatica*), pine (*Pinus sylvestris*), chestnut (*Aesculus hippocastanum*), mahogany (*Swietenia macrophylla*) and sapele (*Sapelli*). The sample sizes are given in Table 1. The veneer backside was stuck to the template of 4.5-mm thick three-layered birch plywood with the glue Moment Montage MV-70. Its viscosity was sufficient to prevent its bleeding through vessels and cracks to the veneer front surface. After gluing, the samples were kept under press for 24 hours. Before engraving the veneer was manually ground with fine abrasive paper. The engraving was performed by the laser LaserPro Mercury II. The engraving modes were selected following the recommendations given in (CHERNYKH 2016, YAKIMOVICH *et al*. 2016). The engraving speed was 0.7 m/sec, the power values recommended in (CHERNYKH 2016, YAKIMOVICH *et al*. 2016) were specified on a trial basis and they were as follows: 6.25 W for beech (*Fagus sylvatica*), 8.75 W for pine (*Pinus sylvestris*) and 5.25 W for other wood species, the resolution was 500 DPI.

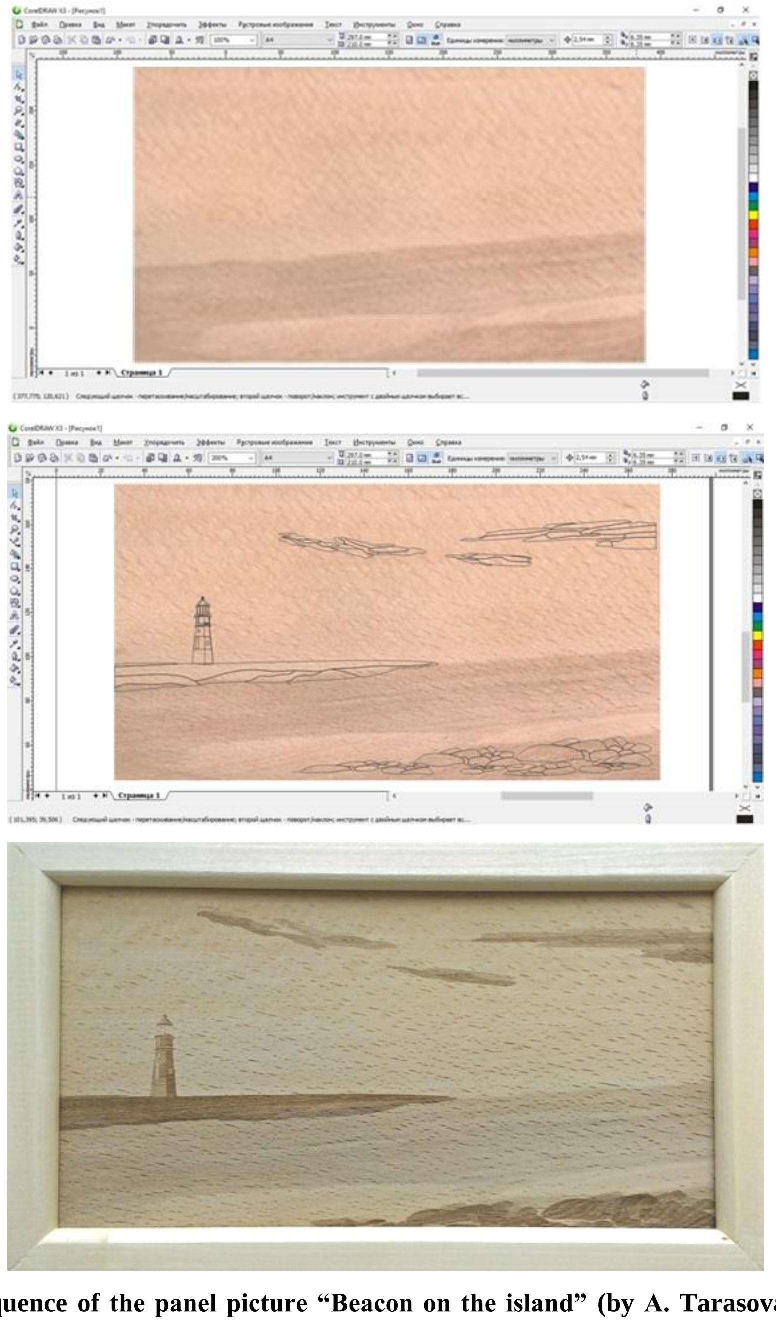
Tab. 1 Sizes of veneer species.

Sample No	Veneer species	Length, mm	Width, mm	Thickness, mm
1	Beech	245	131	0.5
2	Beech	250	131	0.5
3	Pine	249	114	1.5
4	Pine	250	129	1.5
5	Chestnut	245	113	0.5
6	Chestnut	242	130	0.5
7	Mahogany	245	130	1.0
8	Sapele	255	125	0.3
9	Sapele	290	125	0.3
10	Sapele	245	140	0.3

The pattern models for engraving were developed in CorelDraw. The samples were scanned with their further import into the software. The patterns were produced in accordance with the veneer texture. In the sky-line patterns, the final operation was performed on the boundary between the veneer regions with different tones (Fig. 2). The model was a group of objects made in vector graphics on the texture background (Fig. 2b). When the sample was installed on the laser worktable, the veneer texture was aligned with the model texture using the object contours. The aesthetic value of the engravings was assessed with the help of expert evaluation method by three criteria, each on a scale from one to five: aesthetic perception of the engraving in general, composition solution made and pattern contrast against the background. Ten designers took part in the poll. Apart from the expert assessment, the pattern contrast with the background was also found computationally by the technique in (Chernykh 2017), comparing the black colour percentage of the engraved pattern and background measured in CMYK palette on the engraving scans in CorelDraw:

$$k = \frac{k_0 - k_b}{k_b}$$

Where k – tone contrast of the darkest region of the engraving scan with the background;
k_0 – black color percentage of the darkest region of the engraving scan;
k_b – averaged percentage of the background black color.



a) b) c)

Fig. 2 Production sequence of the panel picture "Beacon on the island" (by A. Tarasova): a – beech veneer texture (sample 1 in Table 1), b – creation and editing of the model elements, c – final item (160 × 270 mm).

RESULTS AND DISCUSSION

The investigation results are given in Tables 2 and 3 and in Figs. 3 and 4.

Fine elements of the patterns on all the samples were seen rather distinctly, the veneer burning-out was not observed. The black colour percentage of the models k_m, engravings k_0 and background k_b are given in Table 3. From the Table it is seen that in most cases the engraving tone is much weaker than the models tone. The difference in the model and pattern tone was up to 78% of black colour in CMYK palette (colors is a combination of Cyan, Magenta, Yellow and blacK). This is connected with the tone limit of wood, which has its values not only for each wood species (SHAFRAN 2017, BENDER 2012, ANONYMOUS 2015).

Tab. 2 Sample models.

Sample number, wood species	
1, beech 	2, beech 
3, pine 	4, pine 
5, chestnut 	6, chestnut 
7, mahogany 	8, sapele 
9, sapele 	10, sapele 

The composition solution of the pattern and its contrast with the background simultaneously influence the aesthetic value of the engravings. In general, the engraving aesthetic perception *W* exceeded 4 scores for those samples (samples No 1, 2, 4, 5 and 7), in which both the composition solution of the pattern and its contrast with the background were highly appraised (sample No 3). The aesthetic perception *W* decreases at small values of at least one of their components – composition solution or contrast (samples No 2, 6 and 8). In general, the aesthetic perception goes up with the contrast enhancement (Fig. 4).

The best aesthetic perception is achieved on light wood species having high contrast between the pattern and background. Out of the wood cuts, the best is the one, on which the more successful composition solution is achieved, these can be both the radial (sample No 1, Fig. 2, c) and tangent cuts (sample No 5, Fig. 5).

Tab. 3 Characteristics of sample tone.

Parameter	Sample No									
	1	2	3	4	5	6	7	8	9	10
Model black colour percentage, k_m	90	80	97	100	70	91	90	80	99	100
Engraving black colour percentage, k_0	38	31	26	22	58	68	91	55	66	64
Background black colour percentage, k_b	3	5	8	1	13	16	36	31	40	31
Contrast, k	11.7	5.2	2.3	21.0	3.5	3.3	1.5	0.8	0.7	1.1

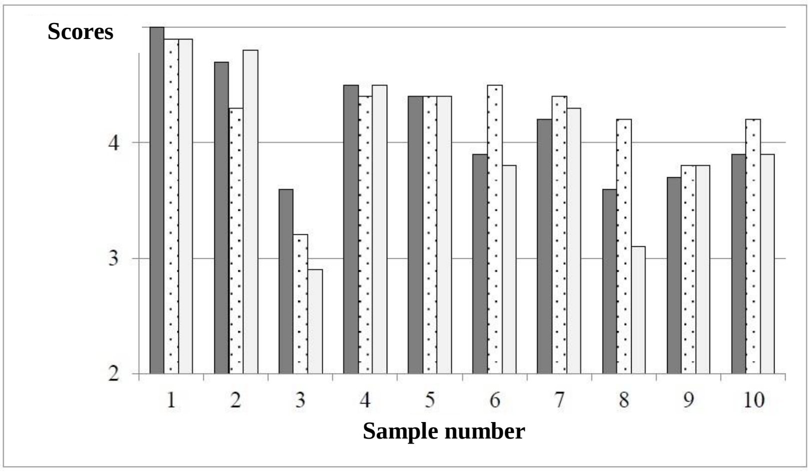


Fig. 3 Bar diagram of the average values of aesthetic perception W of engraved samples ▪, pattern composition solution ⬚ and pattern contrast with background □ .

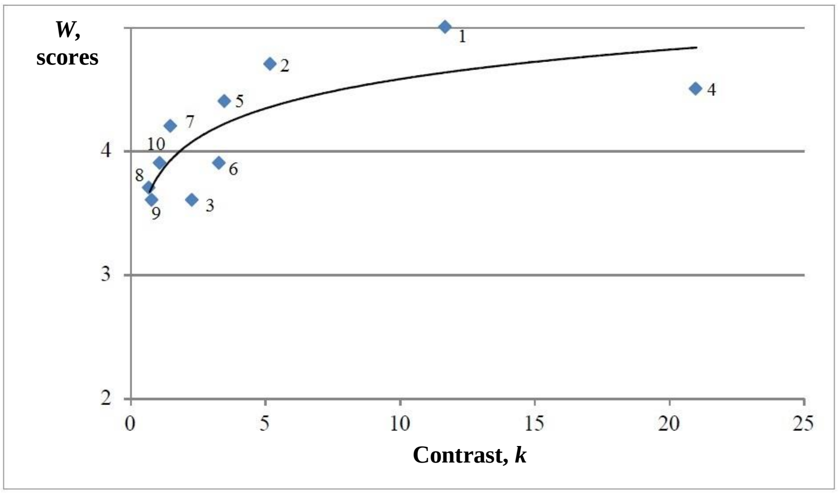


Fig. 4 Dependence of the average values of expert assessments of aesthetic perception W of engraved samples on the contrast between the pattern and background.

Fig. 5 Panel picture "Ship near the shore" made on the chestnut veneer, tangent cut (A. Tarasova).

The use of pine all-heart and sap-wood contrast in the composition (sample No 4) and high degree of glaze of mahogany (*Swietenia macrophylla*) wood (sample No 7) also caused high appraisal of the aesthetic properties of the engravings.

CONCLUSIONS

The use of wood veneer instead of boards when making engravings with the laser expands the possibilities of selecting the texture harmonic with the pattern, the expensive material consumption decreases.

The engraving tone is weaker than the models tone due to the wood tone limit; this needs to be taken into consideration when designing them. In this investigation the difference was as high as 78% of black colour in CMYK palette.

The accepted engraving modes: speed – 0.7 m/sec, power from 5.25 up to 8.75 W depending on the wood species, resolution – 500 DPI provided the obtaining of readable pattern with visually distinctive fine elements and eliminated veneer burning-out.

The aesthetic perception of the engravings depends simultaneously on the achieved contrast of the pattern with the background and successful matching of the pattern with the texture. The aesthetic perception improves with contrast enhancement.

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AUTHORS' ADDRESSES

Prof. Chernykh Mikhail Mikhailovich, DrSC.
Assoc. prof. Kargashina Evgeniia Vladimirovna, PhD.
Izhevsk state technical university of the name M.T. Kalashnikov
Department of Technology of industrial and artistic processing of materials
7 Studencheskaya street
426069 Izhevsk
Russia
rid@isrtu.ru
e.v.kargashina@gmail.com

Assoc. prof. Vladimir Stollmann, PhD.
Technical university in Zvolen
Faculty of Forestry
Department of Forest Harvesting, Logistics and Amelioration
Masarykova 24
960 53 Zvolen
Slovakia
stollmannv@tuzvo.sk