Differences in screen printed letter shapes and stem widths on various textile materials

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Abstract: *In the process of preparing graphic products for printing, it is essential to be familiar with the printing technique which is to be used. In order to achieve maximum printing quality in the printing process, in addition to knowing the printing technique, it is necessary to know how to prepare text and images. Proper font generation process facilitates further usage of text in preparation of printed page.*

This paper will present the research findings concerning the distortion in shape and stem widths letters undergo when printed with screen printing technique on three kinds of textile material. What is examined first is the quality of the text printed on untreated cotton, used for eco bags manufacturing, then on the cotton commonly used for T-shirts production, and finally, on the polyester material.

The aim of this paper is to determine whether there are differences in letter shape and stem widths after they are screen printed on textile, and if there are differences, to quantitatively determine the value of these differences, in order to make certain corrections in the preparation process of the text for printing, or even earlier, in the font generation process.

Printed examples on the textile have been scanned and compared with the original .pdf file, and the analyses have been done using the image processing software ImageJ.

Keywords: *screen printing, textile, text quality, letter area, letter perimeter*

1. Introduction

In order to get a quality print in the process of preparation of printed products for screen printing technique, it is necessary to become familiar with the characteristics of this technique, and be aware of its limitations. The quality of print products is measured not only by the colour reproduction fidelity, but also by the quality of reproduction of the image elements (raster dots, lines, solid ink areas). So in addition to colour reproduction fidelity, in determining the quality of printed materials, one should also take into consideration the quality of the elements it is composed of (Pedersen et al. 2011;Dhopade, 2009).

In their paper, Pedersen et al. 2009 list the attributes that affect the quality of the printed image. All attributes (about 44 of them) that they found in other sources they classified into six categories, since most are overlapping. These are: Colour, Lightness, Contrast, Sharpness, Quality Artifacts and Physical Attributes.

Under the Sharpness Quality Attribute there are also text and line quality as subcategories which are suitable for assessing the quality of printed text. There are various tests for assessing the text quality attributes (detecting letters which are touching, then detecting broken stems of letter characters, connectivity algorithm (Kipman, 1998) and so on.

When it comes to preparing the text for screen printing, one should keep in mind the limitations of the technique. Since the screen printing imprint is produced by squeezing the ink through the screen mesh and the screen is woven from threads that have a certain diameter, about 30% to 60% of the screen will not permit the ink to leak through it (Stivens, 2002). Thus, fine details could be lost during the printing. When printing text, one must make sure that the text is not too small or with too fine details (such as a thin decorative serifs, etc.). According to Stivens, font sizes below 8pt should be avoided. Of course, this varies and depends on the type of letter and fineness of the screen.

The minimum size of the font to be printed on paper should be determined based on the x-height, and not on the basis of the letter body size (x-height with ascenders and descenders) and when printed, it varies depending on the letter type. He concluded that for small letters minimum x-height must be 1.2mm, and for capital letters 1.4mm. For Times New Roman it is 6.5pt, while for Perpetua it is 8.5pt body size. (Poulton, 1972).

According to some sources, the font size for screen printing should not be less than 10pt (Times New Roman), i.e. letter characters stem widths should not be thinner than 0.75pt. (Unknown, 2013)

One of the important parameters for good reproduction of the text is the fineness of the screen or the number of lines per inch (lpi) or per centimetre (l/cm). This is the most important feature of screen printing form, and therefore the most important factor that affects the quality of printing. Low density screens can lead to poor legibility of the text. By measuring the area and perimeter of 6pt letter characters on FOREX PVC plates and on paper, they conclude that the larger the number of lines per centimetre, more similar letter character is to the original, and therefore the readability is better (Stančić et al., 2012).

For printing on fabrics most commonly used screens are of liniature ranging from 35 to 45 lpi. (89 to 114 lines/cm). The recommended resolution in preparation for printing is 1.5 to 2 times higher than screen liniature. Screen liniature that was used in this study is 137 lpi or 54 l/cm.

Another factor that affects the quality of the print is the ink bleeding, i.e. the ability of material to absorb ink. Ink bleeding on the substrate makes the letter characters stems thicker, increasing the area and perimeter of the letters, which can lead to clogging of letter counters on screen or even to connecting of two or more characters. If the value of area and perimeter significantly deviate from the original, it cause deformation of the original design of the letter, and thus reduce the legibility of letters.

2. Methodology

This paper deals with the quality of the text printed using screen printing technique on three different textile materials. Table 1 shows the characteristics of these three materials (Samples). These three materials were tested since they are most commonly used as substrate in textile printing.

Sample 1 is yellow, raw cotton fabric, mainly used for making eco bag. Sample 2 was bleached cotton fabric, most commonly used for T-shirts. Sample 3 was bleached polyester fabric, usually used for printing banners, bags and so on.

Table 1: Characteristics of used textile material

	Material composition	Mass (g/m^2)	Thread count (thread/cm)
Sample 1	100% cotton	139	- basis: 23
			- weft: 21
Sample 2	100% cotton	149	- basis: 19
			- weft: 15
Sample 3	100% polyester	164	- basis: 22
			- weft: 22

White screen with the liniature of 54 lines/cm with a diameter of 64 microns was used for printing, tightened on 310x470 mm frame. Samples of fabric which were printed on were 165x215mm. Test form contained font sizes that are most commonly used on the printed materials for text, logo, contact information and so on. Text was printed in positive and negative. Printed ink was black textile colour Sericol Texopaque Classic OP 004 Trihromaatic Black. The semi-automatic screen printing machine S550 TSH Print Swiss was used for printing. Five copies of each material were printed. Prints were scanned using Mustek P3600 A3 Pro flatbad scanner with 300dpi resolution, measured and analysed in software tool ImageJ 1.46r. The area and perimeter of 4 letters (T, h, q, x) were measured, on both positive and negative in three different sizes (24pt, 16pt and 11pt). Letter "T" as representative of capital letters, letter "h" for letters with ascenders, letter "q" for letters with descenders and letter "x" for small letters. The size below 11pt were not measured, because when screen printed, letters of these sizes tend to clog, stem widths are broken and deformed, and the text is unreadable, and print unrepresentative.

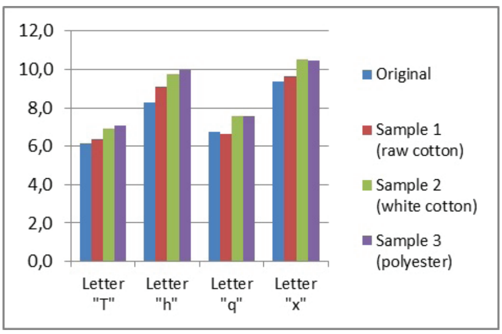
To determine the quality of the printed text, qualitative attributes (Pedersen, 2009) of text readability and changes in thickness of letters were measured. These values, or rather changes of values, were obtained by measuring the area and perimeter of letters.

3. Results and discussion

To determine the exact change in thickness of characters stem widths, two values were measured, area and perimeter. Five copies for each type of material were printed, in order to eliminate errors caused by selecting and measuring regions of interest, i.e. a letter character, to the greatest possible extent. The mean value of these five measurements was taken when comparing the area and perimeter of the original letter characters. The measurement results are shown in Figure 1–6.

3.1 Letter area in positive

After collecting and comparing data, it was evident that there is an increase of the letter area in the positive on all three materials and in all three text sizes (Figures 1,3,5). In the positive, Sample 3 (polyester) shows a larger increase of area compared to the other two materials, which may be due to excessive ink bleeding on this material. On Sample 2 (white cotton), compared to other materials, there is an evident widening of the area in 16pt size category. This may be due to irregularities in the screen pattern development, so the print area on 16pt letters are larger in that region.



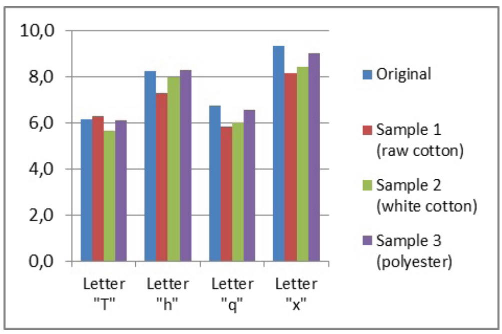
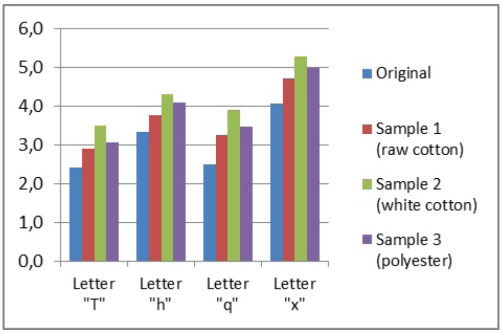


Figure 1: Area (mm^2) 24pt positive and Figure 2: Area (mm^2) 24pt negative



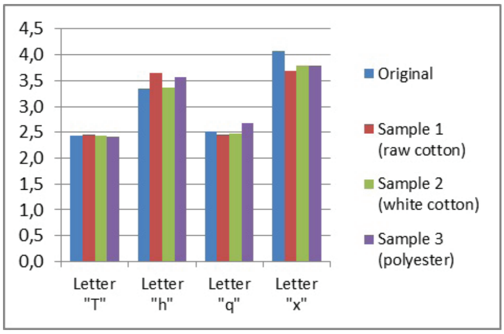
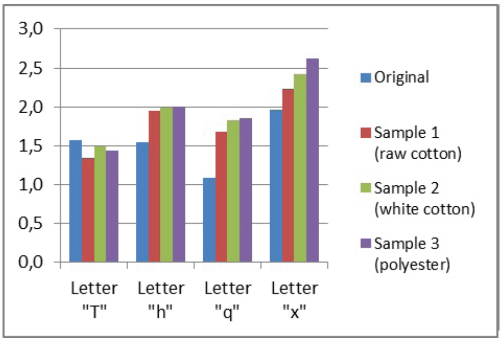


Figure 3: Area (mm²) 16pt positive and Figure 4: Area (mm²) 16pt negative



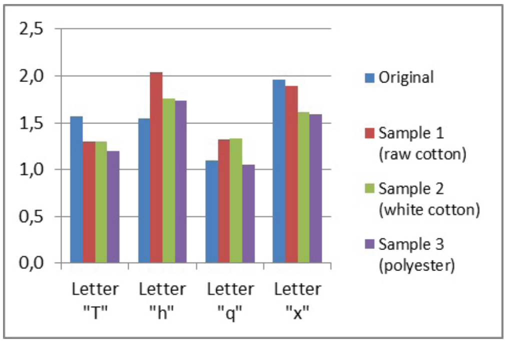


Figure 5: Area (mm²) 11pt positive and Figure 6: Area (mm²) 11pt negative

In the letter „q“ there are certain area changes in 24pt category, depending on the material. Sample 2 of this size has a smaller area than the original, which leads to conclusion that the character stem matched with the screen in such a way that the screen was in part clogged, causing the thinning of the stem. In positive, in the letter „T“, size 11pt, there was deviation in all three samples, i.e. the area is smaller compared to the original. This, as in the other cases, may be due to inadequately developed screen in that region, that is to say, clogging of the screen, which leads to a reduction of letter characters.

3.2 Letter area in negative

In the negative, the changes of the letter area are more unstable (Figures 2,4,6). The analysis of the obtained results show that in more than 50% of cases, the area of letter characters is smaller compared to the original. This means that after ink bleeding on the substrate, the stem thickness of characters was reduced.

For the 24pt text, sample 3 showed a slight decrease in area, which can mean that the ink bleeding is reduced. This could be the result of the development of screen negative in which after the emulsion was hardened, and the letter stem got wider. So, after ink bleeding, there is only a slight reduction of the letter area. For the text size of 16pt, the area of negative letter „T“ is approximately the same for all materials. The area of the letters „h“ and „q“ (sample 3) was larger than the original. The letter „x“ in negative has a smaller area than the original in all three samples. For the text size of 11pt, the area of the letters „T“ and „x“ is smaller, while the area of the letter „h“ is significantly larger in sample 1. As for the letter „q“, sample 1 and 2 have a larger letter area, and on the sample 3 letter area is smaller.

These irregularities may be due to several factors. It may be that the emulsion on the screen hardened, being quite unstable because of the large screen meshes, i.e. small liniature per centimeter, so the emulsion washes off in the border regions of some characters, thus making a larger hole of the printing elements, and consequently, in the letter area. These irregularities can be explained also by the inaccuracy of measurement methods.

3.3 Perimeter of letters

Perimeter of letters is smaller than the original in a negligible number of cases. Increase in the perimeter of letters is the result of ink bleeding, and material properties. This factor depends not only on the quality of the scanned sample, but also on the accuracy of selection of the area of interest. There was no evidence of any significant anomalies here, so we will focus on change in the letter area. Using the equipment of better quality and more precise methods of measurement can provide more accurate information on the changes in the perimeter, and thus the shape of letters.

4. Conclusion

This paper presents the measuring of the quality of printed text of various sizes, in the positive and negative on three different types of fabric (sample 1 – untreated cotton, sample 2– bleached cotton and sample 3 – polyester material). In order to determine the differences in the quality of the text, area and perimeter of the printed letters were measured.

The results show that there was ink bleeding on all three materials and also the increase (on positive) and reduction (on negative) of letters in all sample sizes. The larger the letter, the deviations are more linear, the letter is defined with more screen meshes, and instability of the patterns are less obvious. At smaller sizes, instability in the hardened emulsion becomes more obvious, so the letter shape is more distorted (parts of the stem are broken, obscured), which is visible in the changes of the area and perimeter. In some places there is clogging in the screen mesh on the stems of the letter character, or matching of a part of the letter character with the screen, so instead of an increase there is a decrease of letter area. Measuring the perimeter of the letter points more to the changes in its shape, i.e. the deviations from the original design, and less to the change in stem thickness and increase of the letter area. Materials of coarser weave can cause „jagged" letter edges, which leads to distortion of shape, but not necessarily to clogging of the letter in negative or widening of the letter in positive. All of these parameters should be taken into account when preparing the design for print and be included in the decision-making process in order to get the print of better fidelity and quality. These considerations should also be had in mind when designing a letter for screen printing, for instance, so as not to get an undesired increase or decrease in the letter stem thickness.

This paper has opened the door for further research in this area. In order to get as accurate results as possible, it is desirable to improve the research methodology, by using more precise tools for scanning the prints. In addition, for further research it would be interesting to make screens with different densities of weaving, and compare them. It's also desirable to measure textile capability to absorb ink. In further research more font types could be compared (serif, sans-serif) and it could be researched what features of the typeface are most suitable for screen printing and on which materials.

5. References

1. Pedersen, M., Bonnier, N., Hardeberg, J., Albregtsen, F.: "Attributes of a New Image Quality Model for Color Prints" Proceedings of Color Imaging Conference 2009, (IS&T/SID: Albuquerque, New Mexico, USA, 2009), pages 204–209.

2. Pedersen, M., Bonnier, N., Hardeberg, J: „Image quality metrics for the evaluation of print quality", URL http://colorlab.no/content/download/30728/366341/file/ISQP2011.pdf (last request: 2013-04-25).
3. Dhopade, A.: "Image Quality Assessment According to ISO 13660 and ISO 19751", URL http://cias.rit.edu/~gravure/tt/pdf/pc/TT9_image_quality_assessment.pdf (last request: 2013-05-05).
4. Kipman, Y.: „Image quality metrics for printers and media", IS and TS PICS conference 1998, Society for imaging science & technology, pages 183–187.
5. Stivens, Dž.: "Proces sito štampe", Popesku Books – Group Ltd., Beograd 2002., pages 53–54.
6. Poulton, E. C.: "Size, style, and vertical spacing in the legibility of small typefaces", The Journal of applied psychology, 1972, vol. 56, no. 2, pages 156–161.
7. Stančić, M., Novaković, D., Tomić, I., Karlović, I.: „Influence of substrate and Screen thread count on reproduction of image elements in screen printing", Acta Graphica: Journal for Printing Science and Graphic Communications 23, 2012, pages 1–12.
8. Stančić, M., Karlović, I., Jurič, I.: „Influence of digitally printed self adhesive foils on print Quality parameters", Proceedings - 6th International Symposium on Graphic Engineering and Design GRID 2012, Novi Sad, pages 171–178.
9. Unknown author, http://www.holditbags.com/screen_printing_specs.html, (last request: 2013-05-05)