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In the regions of the Central Europe, recycled fibers represent an important raw material source; however, the recycling rate is despite the public awareness still very diverse. The purpose of the project "Eco(logical) paper circuit" is to raise the awareness and provide tools for efficient collecting of paper and paper packaging, as well as its recycling. It is crucial to recognize the merits of product eco-design and separate collection of paper and paper packaging, which must be developed on mutual cooperation of the regions of the Central Europe. The guiding principle is to increase the level of the sustainable development of the eco(logical) paper circuit.
The project Eco(logical) paper circuit is going to last until the end of 2014.
This project is co-financed by the European Union/European Regional Development Fund (ERDF) and local project partners.

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Poster

BRAILLE TEXT AND RAISED IMAGES USED IN BOOKS FOR CHILDREN WHO ARE BLIND OR VISUALLY IMPAIRED

Gorazd GOLOB[1], Diana GREGOR SVETEC[1], Ana LESKOVŠEK[1], Ana Marija TURNŠEK[1], Igor MAJNARIĆ[2], Taras DUDOK[3], Volodymyr MAYIK[3] & Raša URBAS[1]
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Abstract: *The main goal of our study was to investigate the compliance of existing books in Slovenia for children who are blind or visually impaired with known requirements and standards. As an alternative we have prepared test pages from the book Mali princ (The Little Princ, by A. Saint Exupéry) using UV inkjet printing technique. Results of the analyses were made by legibility and suitability tests based on interviews, made with 11 blind children and their teachers. It was concluded form the results that respondents (children) found Braille text in almost all the samples unlegible. But not all results were bad; our analysis confirmed the suitability of UV-inkjet printing technology for printing Braille. The number of samples and involved blind persons with Braille literacy was not high enough to get statistically valid answers and confirmations, however it was evident that even blind children that are not perfect Braille users can use good UV printed Braille text.*

Keywords: *blindness, Braille, dot profile, legibility, UV-inkjet printing.*

1 INTRODUCTION

World Health Organization reported (in October 2013) that there are 285 million blind and visually impaired people, among which 39 million are blind and 246 million visually impaired [1]. Not all among them read Braille but some research showed [2] that only one out of five school-aged children are actually using Braille.

Blind or visually impaired children should be included in the society and encouraged to build positive relations with their friends, classmates and other people. Nowadays different technical equipment, e.g. computers and smart phones with Braille interface, text to speech and speech to text software, audio books, etc., is available for the people with damaged sight but nevertheless Braille and raised images remain as an important communication tool for them.

General requirements for Braille, used for different purposes, are well known and defined in technical specifications and other publications. Braille for pharmaceutical packaging is determined with EU Directive 2004/27/EC and standard EN 15823 while specifications of dots and textures which can be used in books and other material written in Braille are defined in several recommendations, specifications and other documentation [3-6].

2 EXPERIMENTAL

As already said, the main goal of our study was to investigate the compliance of existing books in Slovenia for children who are blind or visually impaired with known requirements and standards. Research showed that only three of those books, produced in raised screen-printed UV-varnish technique or traditionally embossed are available. The decision was made to include one additional publication into analysis by which the selected book list consisted of: ″Žiga Špaget gre v širni svet″ (A. Kermauner), ″Mi se z vlakom peljemo″ (M. Pergar), ″Zakaj so zebre progaste″ (L. Prap) and ″Center za pomoč slepim in slabovidnim″, Zavod za slepo in slabovidno mladino Ljubljana, 2010. Results of the analyses were made by legibility and suitability tests based on interviews, made with 11 blind children and their teachers.
In the progress of the research a decision was made that certain pages from the book Mali princ (The Little Prince, by A. Saint Exupéry), containing text and illustrations, will be adopted and suitably adjusted for the books intended for the blind children (Figure 1). Chosen text was transformed into Braille and printed on

multilayer UV-inkjet printer Roland VersaUV LEC 300. For the purpose of the research prints were made with different number of layers e.g. different dot height, textures and outline profiles.

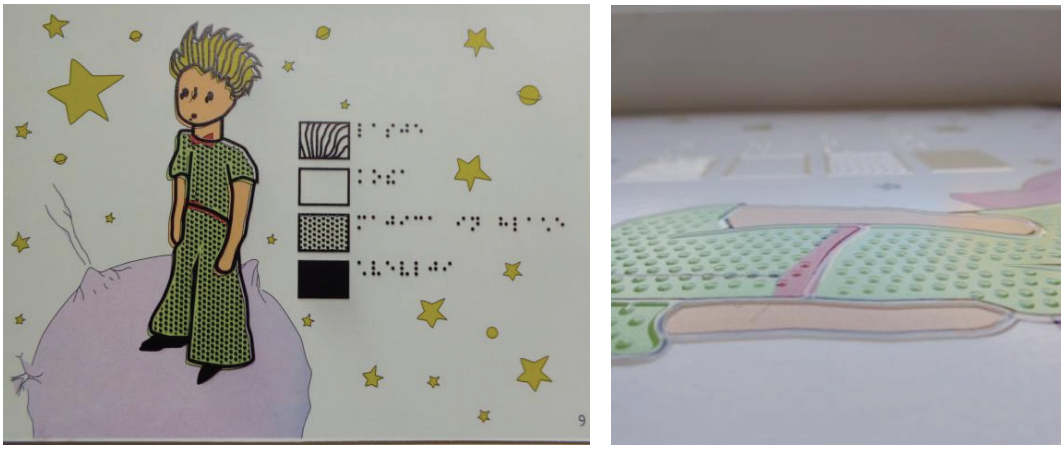

Figure 1: Sample page from the book Mali princ, with illustration, adopted for the people who are blind or visually impaired (left), enlarged detail of raised image (right).

Using perthometer Mahr XC20, and adequate Marsurf software, dot height and profile shape (Figure 2) was measured not only on Braille text from Mali princ but also in all other previously mentioned book samples. Roughness of the substrate and top of the Braille dot was also measured with the same instrument.

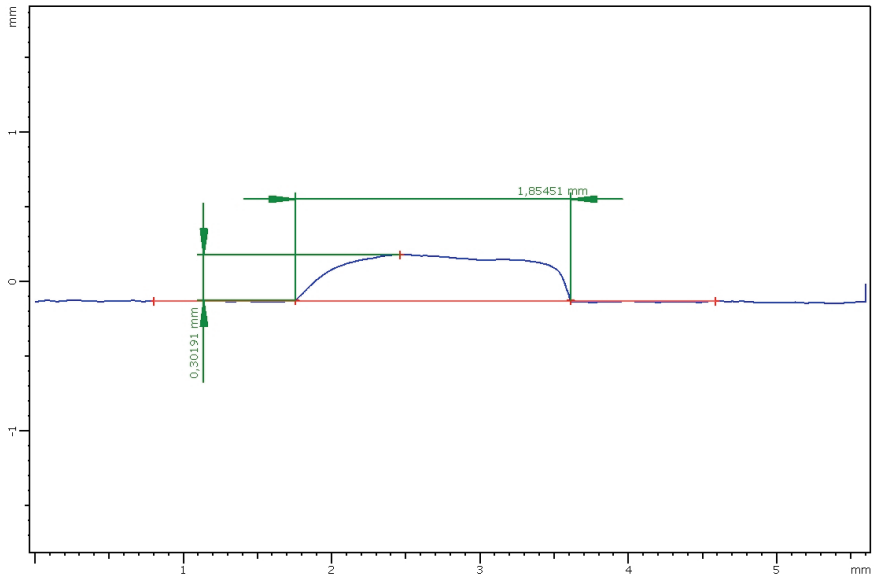

Figure 2: Typical Braille dot profile, measured with using Mahr XC20 perthometer and evaluated by Marsurf profile analysis software.

Six different criteria were set for the evaluation of the Braille print quality: dot height and size, dot surface, spacing between dots, font size, and print substrate. Respondents rated printed samples from four selected books ranking from 1 to 5 (with 1 being the worst and 5 the best).
The most important criteria of all – Braille dot height varied between the samples significantly. Analysis has shown that respondents – children found Braille text in almost all the samples was for the children unlegible. Even raised and/or embossed illustrations couldn't be recognized and understood.

3 RESULTS

Evaluation of the books (Table 1) has been made by 11 persons, children who are blind or visually impaired and their teachers, from the Zavod za slepo in slabovidno mladino (ZSSM, Institute for the Blind and Partially

Sighted Children). Two of respondents were under the age of 10, seven under 20 and two between 30 and 45 years.

Table 1: Results of the evaluation of books from ZSSM library, average rating values are presented with number of respondents in parenthesis.

Book	Mi se z vlakom peljemo	Žiga špaget gre v širni svet	Center za pomoč slepim in slabovidnim	Zakaj so zebre progaste
Dot height	3.4 (11)	1.8 (11)	3.3 (11)	4.4 (11)
Dot size	3.7 (10)	3.6 (10)	3.9 (10)	4.7 (9)
Dot surface	4.0 (11)	4.2 (11)	4.3 (11)	4.6 (10)
Spacing between dots	4.3 (10)	4.8 (9)	4.6 (10)	4.7 (9)
Font size	4.2 (10)	4.5 (10)	4.5 (10)	4.8 (10)
Print substrate	4.0 (11)	4.4 (11)	4.8 (11)	3.6 (10)
Average rating	3.93	3.88	4.23	4.47

Distribution of the ratings for two most important characteristics of Braille text is presented in Figure 2 and 3.

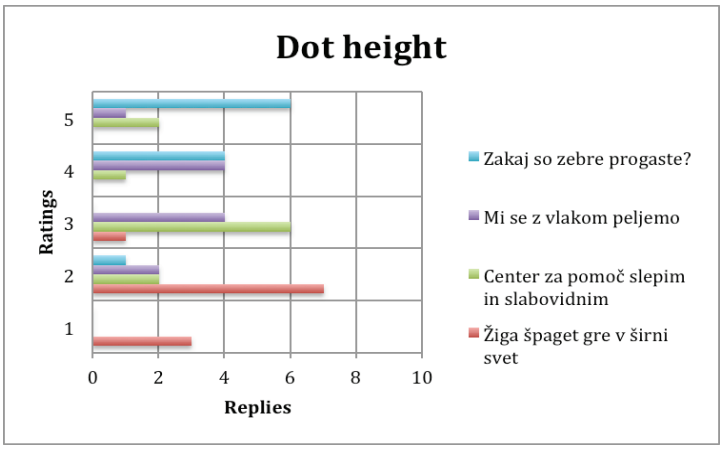

Figure 3: Evaluation of Braille dot height of four books being analysed.

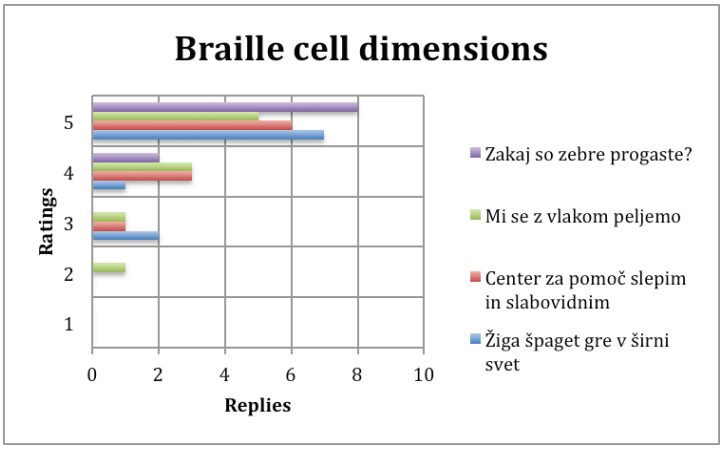

Figure 4: Evaluation of Braille cell dimensions for four book being analysed.

Measurement results (average values of five or more measurements) of Braille dot height, size and roughness of the top of the dot and roughness of the print substrate surface are shown in Table 2.

Table 2: Measurement results of four books obtained using Mahr XC20 perthometer and Marsurf software.

Book	Mi se z vlakom peljemo	Žiga špaget gre v širni svet	Center za pomoč slepim in slabovidnim	Zakaj so zebre progaste
Dot height (mm)	0.136	0.095	0.137	0.195
Dot size (mm)	0.814	1.565	1.643	1.674
Dot surface roughness Ra (µm)	1.988	0.291	0.328	0.339
Print substrate roughness Ra (µm)	1.490	1.784	1.652	0.052

In Table 3 evaluation results of two sample pages from Mali princ are presented. Results were obtained with six blind or visual impaired children. Evaluation included recognition of the picture of little prince, presented in Figure 1.

Table 3: Results of the evaluation of two sample pages of Mali princ, printed with different number of layers.

Sample pages of Mali princ	6 layers	10 layers	11 layers
Dot height	5.0	4.0	3.7
Dot size	4.8	4.3	4.8
Dot surface	4.7	4.5	4.5
Spacing between dots	5.0	4.8	4.8
Font size	5.0	4.8	4.8
Print substrate	4.6	4.5	4.5
Picture recognition	4.5	4.5	/
Average rating	4.8	4.4	4.5

Results of Braille dots and picture elements obtained with Mahr XC20 perthometer and Marsurf software from sample pages of Mali princ are presented in Table 4. Measurements has been taken from printed samples in two directions (MD and CD). Samples printed in high quality mode are thicker due to double layer printed in one pass of printing head, in standard mode only one layer is printed in one pass. First one layer of clear inkjet varnish was used for the preparation (reduction of the ink/varnish penetration) of the print substrate surface.

Table 4: Measurement results of sample pages of Mali princ obtained using Mahr XC20 perthometer and Marsurf software.

Sample pages of Mali princ	Dot / outline profile height (mm)		Dot diameter / line width (mm)		Dot surface roughness Ra (µm)	Print substrate roughness Ra (µm)	
	MD	CD	MD	CD		MD	CD
6 layers – high quality	0.20	0.22	1.92	1.94	0.038	0.376	0.417
6 layers – high quality - picture	0.19	/	1.77	/	/	/	/
10 layers – standard	0.17	0.18	1.85	1.87	0.051	/	/
10 layers – standard - picture	0.16	/	1.64	/	/	/	/
11 layers – standard	0.18	0.18	1.92	1.87	0.219	/	/

4 DISCUSSION

Improvement of Braille legibility of the books for children who are blind or visually impaired was a big challenge after it was established that only a few of those books exist in the libraries and their usability is therefore limited. Technical requirements for Braille text are well documented however pictures that usually appear in children books need special attention. We have found that it is not easy to choose the texture to specific forms on the tactile image. People who are blind connect every tactile contact with their previous experience and this can be very different for each individual. Due to the possible different associations we added the legend to the picture that explains what each texture on tactile raised image means. This idea was well accepted, however further explanations of sighted persons would still be welcome.

Braille text height is most important characteristic regarding legibility and height under 0.1 mm is unsufficient, however text with Braille dot height over 0.2 mm is perfectly legible.

Printer Roland VersaUV Lec 300, which was used for raised printing was proven as a good solution for printing Braille and tactile images. It enabled an accurate application of the varnish according to different visible and Braille text, lines and textures. The final multilayer UV-inkjet printed samples (6 layer high quality mode with double layer thickness), which was rated as the best by blind children, confirmed that legibility is better comparing to the existing books.

5 CONCLUSIONS

Measurements and practical tests of the performed analysis confirmed the suitability of the used method for printing Braille with UV-inkjet technology. The number of samples and involved blind persons with Braille literacy was not high enough to get statistically valid answers and confirmations, however it is evident that even blind children that are not perfect Braille users can use good UV printed Braille text.

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