

Proceedings

7th Symposium of Information
and Graphic Arts Technology

5–6 June 2014 | Ljubljana, Slovenia



University of Ljubljana
Faculty of Natural Sciences and Engineering

Hosted by:

Editor: Raša URBAS

Technical editor: Barbara BLAZNIK

Reviewers: Gorazd GOLOB, Diana GREGOR SVETEC, Aleš HLADNIK,
Klementina MOŽINA, Tadeja MUCK, Raša URBAS

Authors accept responsibility for the whole paper.

Text layout: Barbara BLAZNIK

Cover design: Blaž RAT

Publisher: Univerza v Ljubljani, Naravoslovnotehniška fakulteta, Oddelek za tekstilstvo

CIP - Kataložni zapis o publikaciji
Narodna in univerzitetna knjižnica, Ljubljana

655.1(082)

SYMPOSIUM of Information and Graphic Arts Technology (7 ; 2014 ;
Ljubljana)

Proceedings / 7th Symposium of Information and Graphic Arts
Technology, 5.–6. June 2014, Ljubljana ; [editor Raša Urbas]. – Lju-
bljana : Faculty of Natural Sciences and Engineering, Department of
Textiles, Chair of Information and Graphic Art Technology, 2014

ISBN 978-961-6900-09-6

1. Urbas, Raša
274137856

**EcoPaperLoop**

Public Relations

Oetztaler St 5 B

81373 München • Germany

Tel.: +49 (89) 769 2332

E-Mail: info@ecopaperloop.eu

More information on:

www.ecopaperloop.eu

Univerza v Ljubljani



University of Ljubljana

Faculty of Natural Sciences and Engineering

Department of Textiles

Snežniška 5

1000 Ljubljana • Slovenia

Tel.: +386 (1) 200 32 72

E-mail: diana.gregor@ntf.uni-lj.si

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.

**CENTRAL
EUROPE**
COOPERATING FOR SUCCESS.**EUROPEAN UNION**
EUROPEAN REGIONAL
DEVELOPMENT FUND

ORGANIZER

University of Ljubljana, Faculty of Natural Sciences and Engineering,
Chair of Information and Graphic Art Technology

UNDER THE AUSPICES OF

International Circle of Educational Institutes for Graphic Arts: Technology and Management

iarigai – *The International Association of Research Organizations for the Information, Media and Graphic Arts Industries*

SPONSORSHIP



Kolicevo Karton d. o. o.

Papirniška cesta 1

1230 Domžale



Duropack d. o. o.

Tržaška cesta 1

1370 Logatec



Microsoft

Šmartinska c. 140

1000 Ljubljana

ORGANIZING COMMITTEE

Conference director: Raša URBAS – *University of Ljubljana, Slovenia*

Members: Jure AHTIK – *University of Ljubljana, Slovenia*

Barbara LUŠTEK PRESKAR – *University of Ljubljana, Slovenia*

Blaž RAT – *University of Ljubljana, Slovenia*

PROGRAMME COMMITTEE

Chairman: Aleš HLADNIK – *University of Ljubljana, Slovenia*

Members: Akos BORBELY – *Obuda University, Hungary*

Nils Enlund – *Royal Institute of Technology, Sweden*

Gorazd GOLOB – *University of Ljubljana, Slovenia*

Diana GREGOR SVETEC – *University of Ljubljana, Slovenia*

Igor KARLOVIĆ – *University of Novi Sad, Serbia*

Branka LOZO – *University of Zagreb, Croatia*

Klementina MOŽINA – *University of Ljubljana, Slovenia*

Tadeja MUCK – *University of Ljubljana, Slovenia*

Ondrej PANÁK – *University of Pardubice, Czech Republic*

Raša URBAS – *University of Ljubljana, Slovenia*

TABLE OF CONTENTS

Session A – EcoPaperLoop

- 11 RECOVERED PAPER; WASTE STREAM OR RAW MATERIAL?
Antonia BOŽIČ CERAR
Environmental Protection Department, Chamber of Commerce and Industry of Slovenia
- 12 RECYCLABILITY EVALUATION OF PAPER BASED PACKAGING
Diana GREGOR SVETEC¹, Janja ZULE², Hans-Joachim PUTZ³ & Graziano ELEGIR⁴
¹ *University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of Textiles, Chair of Information and Graphic Art Technology, Slovenia*
² *Pulp and Paper Institute*
³ *Technical University of Darmstadt, Chair for Paper Technology and Mechanical Process Engineering*
⁴ *INNOVHUB-SSI, Paper Research Division*
- 18 RECYCLING AND WASTE MANAGEMENT IN CENTRAL EUROPE COUNTRIES
Diana GREGOR-SVETEC¹, Klemen MOŽINA¹, Mija SEŽUN² & Harald GROSSMANN³
¹ *University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of Textiles, Chair of Information and Graphic Art Technology, Slovenia*
² *Pulp and Paper Institute, Ljubljana, Slovenia*
³ *Dresden University of Technology, Institute of Wood and Paper Technology, Dresden, Germany*
- 24 ENVIRONMENTAL ASSESSMENT OF PAPER PRODUCTS
Damjan BALABANIČ¹, Matej ŠUŠTARŠIČ¹, Matija MRAOVIČ¹, Alen VREČKO¹, Tea TOPLIŠEK¹ & Tadeja MUCK^{1,2}
¹ *Pulp and Paper Institute, Ljubljana, Slovenia*
² *University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of Textiles, Chair of Information and Graphic Art Technology, Slovenia*
- 30 USE OF ULTRASOUND ON HARDWOOD PULP
Tea TOPLIŠEK¹, Matija MRAOVIČ¹, Damjan BALABANIČ¹, Matej ŠUŠTARŠIČ¹, Alen VREČKO¹ & Tadeja MUCK^{1,2}
¹ *Pulp and Paper Institute, Ljubljana, Slovenia*
² *University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of Textiles, Chair of Information and Graphic Art Technology, Slovenia*
- 37 ASSESSMENT OF POSSIBLE IMPROVEMENT OF EU LEGISLATION ON PAPER RECYCLABILITY
Gorazd GOLOB¹, Diana GREGOR SVETEC¹, Raša URBAS¹, Mateja MEŠL², Janja ZULE² & Anja GROŽ³
¹ *University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of Textiles, Chair of Information and Graphic Art Technology, Slovenia*
² *Pulp and Paper Institute, Ljubljana, Slovenia*
³ *Technische Universität Dresden, Faculty of Mechanical Engineering*

Session B1 – Printing, Print Quality, Postpress

- 43 CORRELATION BETWEEN THE LAMS AND PRINTING ELEMENT AREA ON THE FLEXOGRAPHIC PRINTING PLATE
Tamara TOMAŠEGOVIĆ, Sanja MAHOVIĆ POLJAČEK, Tomislav CIGULA, Miroslav GOJO & Diana MILČIĆ
University of Zagreb Faculty of Graphic Arts
- 50 FINDING THE RELATION BETWEEN AM AND FM HALFTONING WITH S-CIE LAB METRICS
Igor KARLOVIĆ, Ivana TOMIĆ, Ivana JURIČ & Ivan PINTIER
University of Novi Sad, Faculty of technical sciences, Department of graphic engineering and design, Serbia
- 55 INFLUENCE OF DIGITAL FLEXOGRAPHIC PRINTING PLATE TYPE ON THE PRINT QUALITY
Rozália SZENTGYÖRGYVÖLGYI¹, Tomislav CIGULA², Ákos BORBÉLY¹, Péter RATKOVICS³ & Ferenc VÁRZA¹
¹ *Óbuda University, Doberdó u. 6, Budapest, Hungary*
² *Faculty of Graphic Arts University of Zagreb, Zagreb, Croatia*
³ *Partners Ltd, Budapest, Hungary*

62 CHARACTERISATION OF THE LIGHT FADING PROCESS
OF PRINTS

Ákos BORBÉLY

Institute of Media Technology, Obuda University, Budapest, Hungary

Session B2 – Printing, Print Quality, Postpress

69 CRITERIA FOR CHOOSING BETWEEN ADHESIVE METHODS
IN CRAFT BOOKBINDING

Suzana PASANEC PREPROTIĆ, Sonja JAMNICKI & Maja JAKOVLJEVIĆ

Faculty of Graphic Arts, University of Zagreb, Zagreb, Croatia

76 COMPARATIVE ANALYSIS OF TONE VALUE REPRODUCTION USING DIFFERENT FILM MAKING
TECHNOLOGIES

Sandra DEDIJER, Živko PAVLOVIĆ, Magdolna PAL & Dragoljub NOVAKOVIĆ

University of Novi Sad, Faculty of Technical Sciences, Department of Graphic Engineering and Design

81 HOW MUCH THE MEASURING CONDITIONS MAY INFLUENCE
THE CALCULATED COLOUR

Marta KLANJŠEK GUNDE¹, Rahela KULČAR², Maja JAKOVLJEVIĆ², Mojca FRIŠKOVEC³, Metka HAJZERI^{1,3},
Maša HORVAT¹ & Nina ROGELJ⁴

¹ *National Institute of Chemistry, Ljubljana, Slovenia*

² *Faculty of Graphic Arts, University of Zagreb, Zagreb, Croatia*

³ *Cetis, Graphic and Documentation Services, d.d., Slovenia*

⁴ *Color in Informatics and Media Technology (cimet), coordinated by University Jean Monnet, Faculty of Science and Technology, Saint-Etienne, France; currently with University of Eastern Finland, Institute of Photonics, Joensuu, Finland*

87 DESIGN AND SIMULATION OF META-PAPER FOR FREQUENCY
SELECTIVE OPERATION

Matija MRAOVIĆ¹, Miloje ĐOKIĆ², Matej PIVAR², Tadeja MUCK^{1,2} & Anton PLETERŠEK³

¹ *Pulp and Paper Institute, Ljubljana, Slovenia*

² *University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of Textiles, Chair of Information and Graphic Art Technology, Slovenia*

³ *ams ReD, Ljubljana, Slovenia*

Session C1 – Typography, Readability, Design

93 ON-SCREEN TEXT LEGIBILITY AMONG CROATIAN
AND SLOVENIAN LANGUAGE GROUPS

Dorotea KOVAČEVIĆ¹, Nace PUŠNIK², Maja BROZOVIĆ¹ & Klementina MOŽINA²

¹ *University of Zagreb, Faculty of Graphic Arts, Department of Art History and Graphic Design, Zagreb, Croatia*

² *University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of Textiles, Chair of Information and Graphic Art Technology, Slovenia*

98 HEURISTIC EVALUATION OF ICT APPLICATIONS FOR PERSONS
WITH COMPLEX COMMUNICATION NEEDS

Jesenska PIBERNIK, Bojan KANIŽAJ, Jurica DOLIĆ, Lidija MANDIĆ & Maja STRGAR-KUREČIĆ

Faculty of Graphic Arts University of Zagreb

102 INFLUENCES OF THE GESTALT PRINCIPLE ON THE SYSTEM
OF MORPHOLOGICAL LAWS

Vojko POGAČAR¹ & Kaja POGAČAR²

¹ *University of Maribor, Faculty of Mechanical Engineering, Maribor, Slovenia*

² *University of Maribor, Faculty of Civil Engineering – Architecture, Maribor, Slovenia*

Session C2 – Typography, Readability, Design

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

Gorazd GOLOB¹, Diana GREGOR SVETEC¹, Ana LESKOVŠEK¹, Ana Marija TURNŠEK¹, Igor MAJNARIĆ², Taras DUDOK³, Volodymyr MAYIK³ & Raša URBAS¹

¹ University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of Textiles, Chair of Information and Graphic Art Technology, Slovenia

² University of Zagreb, Faculty of Graphic Arts

³ Ukrainian Academy of Printing, Lviv

115 INFLUENCE OF DISPLAY CONTRAST ON TEXT READABILITY ON DIFFERENT HANDHELD DEVICES

Bojan BANJANIN & Vladimir ZORIĆ

University of Novi Sad Faculty of Technical Sciences, Novi Sad, Serbia

Session D1 – Spectroscopy, Microscopy, Image Analysis

121 APPLICATION OF FTIR SPECTROSCOPY FOR IDENTIFICATION OF CONSTITUENTS OF DOCUMENTS

Milena REHÁKOVÁ, Eva BELÁNYIOVÁ, Katarína VIZÁROVÁ, Jana PROVAZNÍKOVÁ, Michal ČEPPAN & Vladimír DVONKA

Slovak University of Technology, Faculty of Chemical and Food Technology, Institute of Natural and Synthetic Polymers, Bratislava, Slovakia

128 METHODS OF MOLECULAR SPECTROSCOPY AND CHEMOMETRY IN EXAMINATION AND RE-SEARCH OF GRAPHICAL DOCUMENTS

Michal ČEPPAN, Michaela BELOVIČOVÁ, Lukáš GÁL, Milena REHÁKOVÁ, Vladimír DVONKA & Pavol GEMEINER

Slovak University of Technology, Faculty of Chemical and Food Technology, Institute of Natural and Synthetic Polymers, Bratislava, Slovakia

135 SEM STUDIES OF PURE Fe_2O_3 PARTICLES AS A MAIN CONSTITUENT OF IRON OXIDES GROUP OF INORGANIC PIGMENTS

Andreja JELEN¹, Janez DOLINŠEK^{1,2} & Marica STAREŠINIČ³

¹ Faculty of Mathematics and Physics, University of Ljubljana, Ljubljana, Slovenia

² Solid State Physics Department, J. Stefan Institute, Ljubljana, Slovenia

³ University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of Textiles, Chair of Information and Graphic Art Technology, Slovenia

Session D2 – Spectroscopy, Microscopy, Image Analysis

141 IMAGE ANALYSIS OF 3D CLOTH SIMULATION AS A FUNCTION OF COLLISION OBJECT GEOMETRY

Helena GABRIJELČIČ TOMC & Aleš HLADNIK

University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of Textiles, Chair of Information and Graphic Art Technology, Slovenia

147 PCA AND FIBER OPTICS VIS-NIR AND NIR REFLECTANCE SPECTRA FOR EXAMINATION OF INKJET PRINTS IN FORENSIC ANALYSIS

Lukáš GÁL, Michal ORAVEC & Michal ČEPPAN

Department of Graphic Arts Technology and Applied Photochemistry, Faculty of Chemical and Food Technology, Slovak University of Technology in Bratislava, Bratislava

154 PRINT MOTTLE ASSESSMENT OF SCREEN PRINTED TEXTILE MATERIAL

Rastko MILOŠEVIĆ¹, Nemanja KAŠIKOVIĆ¹, Dragoljub NOVAKOVIĆ¹,

Ivana JURIC¹ & Mladen STANČIĆ²

¹ University of Novi Sad, Faculty of Technical Sciences, Graphic Engineering and Design, Novi Sad, Serbia

² University of Banja Luka, Faculty of Technology, Graphic Engineering, Banja Luka, Bosnia and Herzegovina

Poster

- 161 MENU VS. SEARCH BOX IN TWO ONLINE SHOPS
Andrej ISKRA & Helena GABRIJELČIČ TOMC
*University of Ljubljana, Faculty of Natural Sciences and Engineering,
Department of Textiles, Chair of Information and Graphic Art Technology, Slovenia*
- 167 XYZ TO RGB COLOR TRANSFORMATIONS USING ARTIFICIAL NEURAL NETWORKS
Mihael LAZAR, Dejana JAVORŠEK, Primož WEINGERL & Aleš HLADNIK
University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of Textiles, Chair of Information and Graphic Art Technology, Slovenia
- 173 FTIR SPECTROSCOPY OF MAGENTA INK-JET PRINTS AFTER EXPOSURE TO LIGHT
Barbara BLAZNIK¹, Marta KLANJŠEK GUNDE² & Sabina BRAČKO¹
¹ *University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of Textiles, Chair of Information and Graphic Art Technology, Slovenia*
² *National Institute of Chemistry Slovenia*
- 180 APPLICATION OF CIECAM02 TO 3D SCENE IN BLENDER
Nika BRATUŽ, Helena GABRIJELČIČ TOMC & Dejana JAVORŠEK
University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of Textiles, Chair of Information and Graphic Art Technology, Slovenia
- 187 RAISED PRINTING WITH SCREEN PRINTING TECHNIQUE
Urška STANKOVIČ ELESINI¹, Boštjan ŠUMIGA², Stefan MANOJLOVIĆ¹ & Raša URBAS¹
¹ *University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of Textiles, Chair of Information and Graphic Art Technology, Slovenia*
² *Iskra Mehanizmi, d.o.o., Slovenia*
- 193 REPRODUCTION OF COLOR IN 3D SPACE IN DEPENDENCE OF GAMMA VALUES, TEXTURE AND ILLUMINATION
Helena GABRIJELČIČ TOMC, Nika BRATUŽ & Dejana JAVORŠEK
*University of Ljubljana, Faculty of Natural Sciences and Engineering,
Department of Textiles, Chair of Information and Graphic Art Technology, Slovenia*
- 199 WEBSITE PLANNING AND DEVELOPMENT THROUGH STUDYING PROCESS
Gašper KOROŠEC¹, Helena GABRIJELČIČ TOMC¹, Andrej ISKRA¹ & Anja KOSOVEL²
¹ *University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of Textiles, Chair of Information and Graphic Art Technology, Slovenia*
² *Freelance digital communication consultant, Nova Gorica, Slovenia*
- 206 A NOVEL DATABASE FOR EVALUATION OF DIGITAL IMAGES
Jure AHTIK, Tadeja MUCK & Marica STAREŠINIČ
University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of Textiles, Chair of Information and Graphic Art Technology, Slovenia
- 211 APPLICATION OF CONVENTIONALLY MADE CLICHE FOR PAD TRANSFER PRINTING ON NAILS
Tina VELECHOVSKY, Raša URBAS & Maja KLANČNIK
University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of Textiles, Chair of Information and Graphic Art Technology, Slovenia
- 218 GRAPHIC PAPER FROM EUCALYPTUS
Diana GREGOR SVETEC, Manca ARKO & Klemen MOŽINA
*University of Ljubljana, Faculty of Natural Sciences and Engineering,
Department of Textiles, Chair of Information and Graphic Art Technology, Slovenia*
- 223 COMPARISON OF PROFESSIONAL DIGITAL CAMERA SENSOR GAMUTS USING PHOTOSHOP AND DCRAW BASED METHODS
Andrej UČAKAR & Aleš HLADNIK
University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of Textiles, Chair of Information and Graphic Art Technology, Slovenia

228 COMPARISON OF TWO DIGITAL THERMAL OFFSET PRINTING PLATES

Ana JEREB, Dejana JAVORŠEK & Maja KLANČNIK

University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of Textiles, Chair of Information and Graphic Art Technology, Slovenia

235 ADSORPTION OF PRINTING INK FROM WASTEWATER

Tanja TABOR & Maja KLANČNIK

University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of Textiles, Chair of Information and Graphic Art Technology, Slovenia

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

Gorazd GOLOB¹, Diana GREGOR SVETEC¹, Ana LESKOVŠEK¹, Ana Marija TURNŠEK¹,
Igor MAJNARIĆ², Taras DUDOK³, Volodymyr MAYIK³ & Raša URBAS¹

¹ University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of Textiles,
Chair of Information and Graphic Art Technology, Slovenia

² University of Zagreb, Faculty of Graphic Arts

³ Ukrainian Academy of Printing, Lviv

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 Prince, 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 from 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.

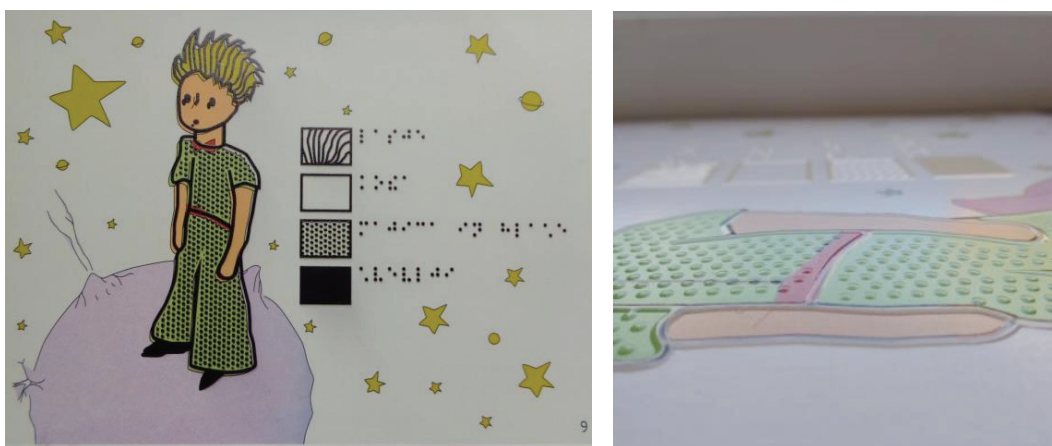


Figure 1: Sample page from the book Mali princ, with illustration, adopted for the people who are blind or visually impaired (left), enlarged detail of raised image (right).

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.

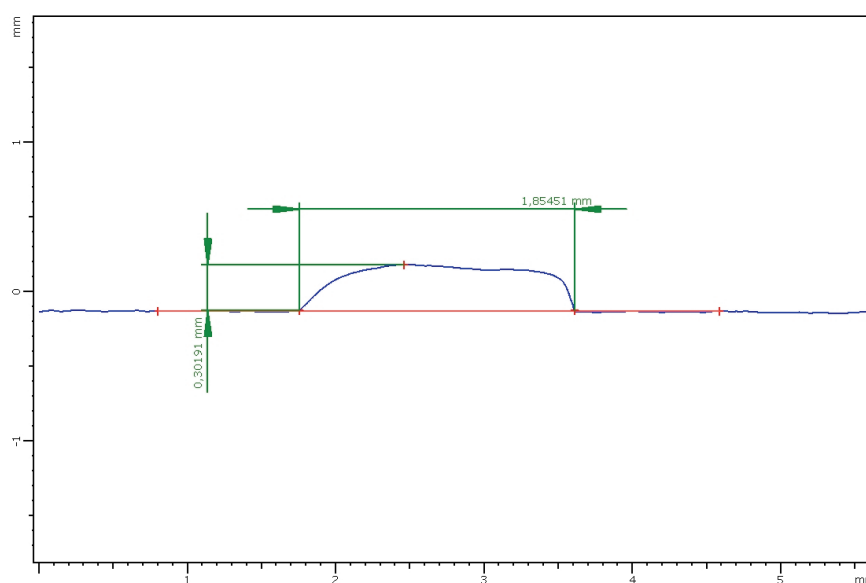


Figure 2: Typical Braille dot profile, measured with using Mahr XC20 perthometer and evaluated by Marsurf profile analysis software.

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.

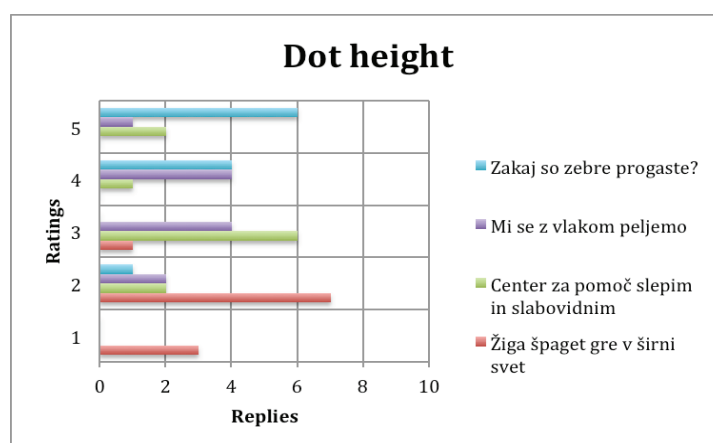


Figure 3: Evaluation of Braille dot height of four books being analysed.

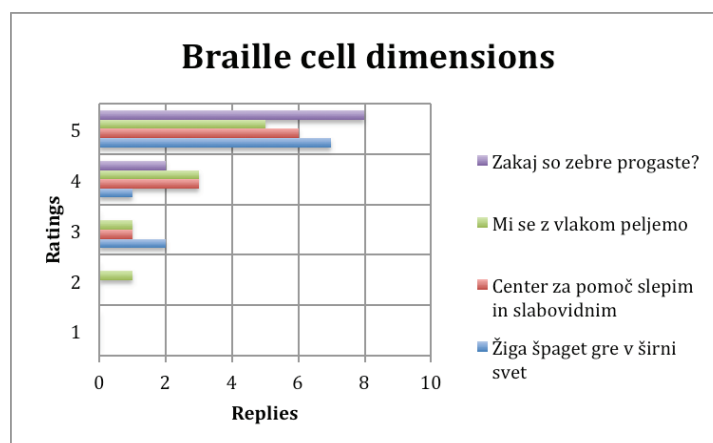


Figure 4: Evaluation of Braille cell dimensions for four book being analysed.

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 insufficient, 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.

6 REFERENCES

- [1] Mediacentre: World health organization, *Available from* <http://www.who.int/mediacentre/factsheets/fs282/en/index.html> Accessed: 2014-02-21
- [2] BRVAR, R. *Dotik znanja : slepi in slabovidni učenci v inkluzivni šoli*. 1.izdaja. Ljubljana, Modrijan, (2010), pp. 7-8, 42-43
- [3] FAJDETIĆ A.: Standardisation of Braille in the EU and other European Countries. *Proceedings of World Congress Braille21 : innovations in Braille in the 21st century* pp. 27-30, Leipzig, Germany, September, (2011)
- [4] KRIVEC, T.: *Prilagoditev reprodukcije umetniške slike slepim in slabovidnim s tehniko reliefnega tiska: diploma thesis*, Ljubljana, (2012)
- [5] LESKOVŠEK, A.; TURNŠEK, A.M.: Optimizacija Braillove pisave v tehniki digitalnega tiska: *diploma thesis*, Ljubljana, (2014)
- [6] SALZHAUER AXEL, E.; SOBOL LEVENT, N.: Art beyond sight : a resource guide to art, creativity and visual impairment. *American Foundation for the Blind*. New York : Art Education for the Blind, (2003), pp. 77, 86, 104