The Influence of Print Technology on the Image Quality of Convex Braille Printouts for the Blind

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Abstract

People with visual impairment and blindness are a significant population in the modern world. Their active and independent participation in society can depend largely on their education, which is greatly enhanced by access to convex print resources. Enhancing image quality while reducing production costs is a dichotomy when developing resources used for the education of people with visual impairment. Due to rapid technological progress, analyzing the influence of technology on the quality of convex printing is justified.

This paper will describe:
- traditional and novel methods of manufacturing convex prints,
- an analysis of the influence of production method on Braille character quality,
- the results of preliminary measurements,
- suggestions for the further development of particular technologies.

Technologies for Convex Print Production

Convex prints for use by people with visual impairment can be created using a variety of methods. Among them are embossers, thermal swell papers, vacuum thermoforming and ink-jet process.[1-3]

Convex features can be created by a variety of dedicated Braille **embossers.** They share the same underlying technology but can differ greatly in print speeds: slow hand operated (to 20 characters per second), electronically operated (up to 40 cps), and computer printing (up to 120 cps). Examples of embossed Braille dots are presented in Figure 1.

The properties of an embossed Braille character are dependant on the properties of the paper (e.g. strength, scratch resistance, elasticity, rigidity and smoothness – see Figure 2), and the mechanical properties of the embosser (e.g. force of embossing, hammer geometry, the movement of the embossing head, etc).

These properties determine the construction of the printer, which in turn affects the quality and longevity of the embossed characters. A positive aspect of embossers is the ability of some to print at high speed. A negative property, common to all Braille printers, is loud noise (due the impact nature of the hammers), which in some cases reaches 120 dB.

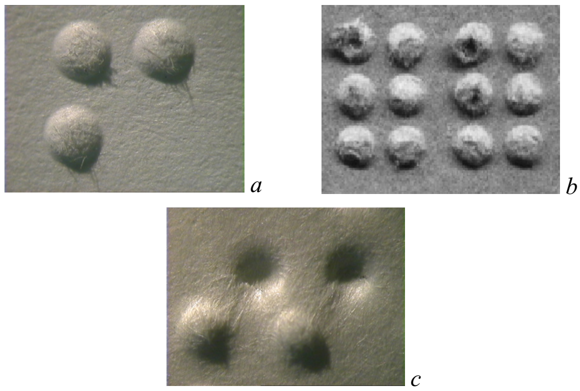


Figure 1. Enlarged view of embossed Braille characters; (a) good printing (single sided), (b) poor printing (defected dots), (c) double sided printing.

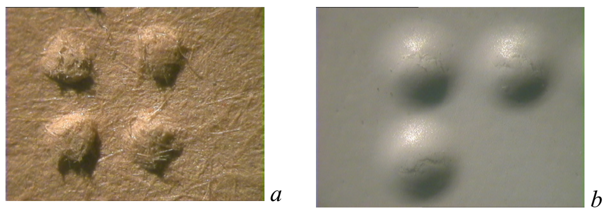
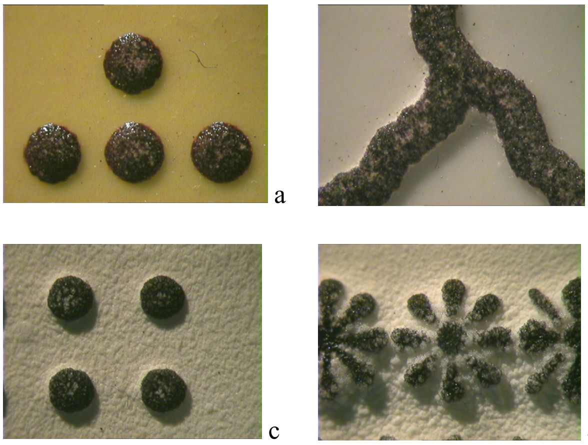


Figure 2. The shape of Braille dots on (a) rough paper and (b) a quality smooth paper.

Convex prints can be made using **swell paper**, a special paper pre-impregnated with heat sensitive microcapsules.

The swell paper production process comprises two phases: firstly producing a black and white or grayscale flat image on a sheet of swell paper (realized using a conventional printer), and secondly, exposing the paper with the flat image to a thermal machine (e.g. a fuser). Figure 3 shows examples of convex prints made with swell paper.



a b c d

Figure 3. Microscopic view of swell paper features. (a) Braille dots, (b) lines from a tactile diagram, (c) Braille dots deformed in transport and (d) poor swelling due to excessive temperature.

Black areas in the flat copy absorb more energy during heating, causing swelling of the polymer microcapsules (up to 80 times), leaving the non-black areas flat, and thus creating the convex print.

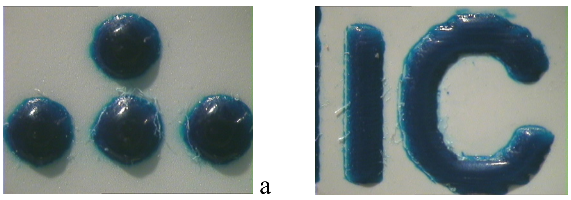
The quality of a swell paper convex print is dependant on several parameters, such as the level of blackening, paper properties, print mechanism and the time and temperature of heating. Swell paper is cheap, clean and relatively simple, though the finished features sometimes lack clarity and robustness.

The process of **vacuum thermo-forming** a plastic film over a pre-prepared master pattern is an older technology. The key disadvantage of this method is the time and expense of creating the master pattern.

A new technology is for creating convex prints is **ink-jet printing**. By repeatedly printing layers of polymer inks using an industrial print-head, convex structures can be created on a variety of substrates.[4] Inkjet Braille dots and tactile features have very smooth surfaces and good overall quality as shown in Figure 4 and Table 1. (H – height of dot, d – diameter of dot, R_a– roughness).

Table 1. Measurement Details of Selected Quality Parameters for Ink-Jet and Embossed Paper Samples.

Sample	Ink Jet 1	Ink Jet 2	Ink Jet 3	Paper 1	Paper 2
H [mm]	0,44	0.31	0,36	0,38	0,25
d [mm]	1,50	1,44	1,56	1,62	1,32
R_a [μm]	*	0,68/1,42	0,58/1,38	8,21	7,84



a b

Figure 4. Microscopic view of convex ink-jet samples.

The ink-jet samples assessed so far have been an acrylic ink on a PVC substrate, though other polymer inks and substrates could easily be used. Using ink jet technology for convex printing is modern and evolutionary. Samples are very durable and allow the use of digital images, which are easily stored and manipulated. Disadvantages of the technology are the high capital cost of the printer and the complexity of the process and materials.

Conclusions

The progress of convex printing techniques is important for improving the lives of people with visual impairments. Some important trends in the development of convex printing technologies are:

- improvement of the embossing process – increasing the output rates while reducing cost.
- a reduction in costs of microcapsule papers for swelling processes.
- the development of novel process such as ink jet.

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Biography

Roman Barczyk is a PHD Student at Institute of Micromechanics and Photonics at Warsaw University of Technology (since February 2004). His work is mostly focused on problems of quality of convex copies for blind and visually impaired people.