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Examination of the relative age of documents. Part II Document dating examination of non-intersecting handwriting and laser print

Summary

The article presents the results of the examination of dating non-intersecting handwriting and laser print. Based on microscopic viewing, typical features of writing made in blank and put through a laser printer, were isolated and described.

Keywords toner, laser printer, inks

Introduction

Since the 1990s, printing and copying devices have seen rapid development. Manufacturers improve their products so as to produce high quality documents at low production costs as quickly as possible. The widespread availability of such devices means that most of the office or home documents are created on computer printers. There has been an increase in crime involving falsification or forgery of various kinds of printed documents. One of the problems related to this fact is establishing the dating of handwritten intersecting entries and print constituting essential content of the document. This applies to documents signed in blank and then supplemented with content inconsistent with the intention of the person signing. In this way new documents can be created, for example, bills, liabilities, receipts, wills etc., charging the person who put their signature in blank; also the documents authenticity is questioned by the person, claiming that he/she did not sign that document, as the signature was put in blank for preparing the document with quite different contents.

Till now, document examiners have not been in command of an effective diagnostic methodology of examining falsified documents such as documents signed in blank or including additional printing, if they did not contain intersecting entries. As part of the research work carried out by the Polish Forensic Association and the University of Warsaw have pursued a development project entitled "Development of a methodology and the creation of a position for document dating examination of entries made with different techniques and inks on paper" [1][1], and in the Forensic Research Office of the Internal Security Agency, tests were carried out in order to develop a safe method to help enable the determination of the order of entries on a document prepared by laser printer.

A laser printer [1] is comprised of the following parts:

- photoconductive drum,
- laser,
- toner cartridge,
- transport system,
- fuser unit.

The photoconductive drum (1) is covered with a photoconductive layer, which is, in most cases, a photoconductive resin layer of zinc oxide. The photoconductive layer is electrified by the so-called corona discharge by means of special brushes or wires (2) arranged transversely to the direction of rotation of the drum. Then, due to using a laser beam (3), deflected by a system of mirrors, a monochrome image of the printed page is mapped on the drum. In places where the laser beam touches the surface of the drum, the previously applied charge is removed. The charge located in unexposed areas creates a so-called electrophotographic latent image. Developing the latent image consists in exposing the image with a

[1] Development project carried out under contract No. 0019 / R / T00 / 2010/11 dated 26.08.2010. Execution of development project 0 R00 001911 concluded between the Minister of Science and Higher Education and the Consortium of the University of Warsaw and the Research and Training Centre of the Polish Forensic Association.

powder (toner) (4) of a charge opposite to that provided on the photoconductive layer. This can be performed using various methods: cascade development with the fur brush, magnetic brush method using a dust cloud or dispersion. The toner image, which is obtained as a result of developing, is then transferred to another substrate, that is the paper (5). The transfer of the image is the effect of attracting the toner by the paper which was charged earlier (6) with a charge opposite to that of the toner. The image exposed on the paper is normally fixed by thermal fusion (8). The toner, molten under high temperature (140-200 ^{0} C), adheres to the substrate. This process is assisted by pressing the powder into the paper by pressure rollers. The paper with the molten toner is transported to the receiver, and the photoconductive layer is completely discharged (8) and cleaned (9) in order to start working again.

In the laser printer, the print fixing involves melting the toner into the paper and then pressing the paper to the base for more a permanent connection [2]. The high temperature[2] is likely to cause changes in the physical properties of deposited inks, and the high pressure can disrupt the letter characters or distort the relief [3]. Moreover, during printing the printer leaves some additional traces in the form of toner particles on the paper surface (Fig. 1. Structure of a monochrome laser printer and how it works; see Polish version).

The fact of thermal changes that affect earlier ink deposits (e.g. signatures in blank) on a paper surface at the time of electrophotographic printing was pointed out by prof. M. Owoc [4]. In earlier photocopiers, the thermal fusing of toner on paper was obtained by exposure to a high power halogen lamp with temperatures exceeding 200°C. More recent designs of photocopiers and computer laser printers use temperatures of 140–200°C, which gives an idea of the scale of thermal processes accompanying this technique of printing documents. The thermal influence has an effect on inks previously applied to the substrate. At this temperature, the hardened oils and resins producing the structure of a "dried" ballpoint pen strokes are subject to plasticization, as well as some metal stamp prints, and tragacanth gum used as a pencil binder; wax as part of the structure of crayons also softens [4].

Examination objective, preparations and description

Making use of the above assumptions, tests were carried out to check whether it is possible, on the basis of microscopic viewing, to assess the order of non-intersecting signatures made in blank, with written amendments printed on a laser printer and to develop a test method allowing a reliable assessment of this kind of document dating examination.

For the needs of the examination, the written entries were prepared on two types of paper:

- "Xerox" paper of 80 g / m^2 grammage,
- "Gohrsmühle mill" paper of 90g / m^2 grammage.

The entries were made with different inks:

- ballpoint pens ("Pilot RFJS / BSRF6 F", "Zenith", "BIC medium", "Pant", "Xinhua", "Pilot BPS-GP", "STAR", "Remote RFJS / BSRF6 F") of colours: blue – 5 types, black – 5 types, green – 3 types;
- fountain pens ("Sheaffer", "Mont Blanc", "Waterman") of colours: blue – 2 types, black – 3 types, brown – 1 type;
- felt-tip pens ("Wang Neng", "Fineliner", "Taurus", "Stabilo") of colours: black – 2 types, blue – 2 types, red – 2 types, green – 2 types;
- markers ("Kamet") in colours: black – 1 type, blue – 1 type, red – 1 type, green – 1 type, brown – 1 type;
- gel pens ("Rystar") of paste colours: black – 1 type, blue – 1 type, red – 1 type, green – 1 type.

On samples prepared this way, the text was printed using a laser printer HP Colour LaserJet 2600n:

- 3 days after making personal written entries,
- 7 days after making personal written entries,
- 21 days after making personal written entries,
- 91 days after making personal written entries.

It was assumed that the high temperature and stress should result in changes in physical properties of the inks being used.

The personal written entries, put through a laser printer, were analysed using Nikon 80i microscope equipped with a colour DS-fI1-DS-U2 digital camera, of 5.24 million pixels resolution. The viewing was made using the following lenses:

- LU Plan Epi P 5X N.A. 0.15, W.D. 23.5 mm,
- CFI LU Plan Epi P 10X N.A. 0.3, W.D. 17.3 mm,
- CFI LU Plan Epi P 20X N.A. 0.45, W.D. 4.5 mm,
- LU Plan Epi P 50X N.A. 0.08 W.D. 1.0 mm.

In the illuminator of the passing light the latest solution was used, that is the "fly-eye" system. This causes an even illumination of the entire working area and thus eliminating the phenomenon of an underexposed rim. The microscope also gives the opportunity of scanning individual layers of the image which, putting them together, make a three-dimensional image. It is additionally equipped with a confocal adapter, which means that the examined object is illuminated by three lasers: blue – 408 nm, green – 488 nm, red – 543.50 nm. The laser light penetrates deep into the examined structure taking a sequence of shots shifted in the vertical Z axis, and the NIS Elements AR 3.00 specialist software reconstructs the specimen appearance. Figure 2 shows camera parameters and figure 3 presents flow chart of the confocal attachment; see Polish version).

[2] Earlier in the BBK ABW, using ECLIPSE 80i microscope system with a confocal adapter, tests were performed to determine the fact of printing additional contents to the existing text, using printing devices with a thermal fusing function.

The viewing was carried out in visible light and the confocal adapter, using laser light.

For the analysis of the microscopic "live" image and 3D images, the NIS Elements AR 3.00 [5] program was used.

370 samples were viewed at different magnification, lighting and configurations. Altogether, a total of about 3330 images were analysed.

In order to verify the effectiveness of the developed examination method, a control test was carried out in which 60 samples were examined containing non-intersecting handwritten entries and printouts of unknown, for the examining person, dating of the deposits. In the case of 56 samples, their dating was defined correctly.

The examination results and sample photos are shown below.

Examination results

As a result of comparing the entries put through a laser printer with those not put through a laster printer, the following differences were found:

- fading of the colours in the case of the handwritten entries made with blue, black and green ballpoint pen and fountain pen inks run through a laser printer (example in Fig. 4 Entry with a green ink ballpoint pen, not put through in a laser printer – fifty times magnification; Fig. 5 Entry made with a green ink ballpoint pen, put through a laser printer – fifty times magnification; see Polish version).
- blurred ink after being put through a printer, which is also seen in the line of writing in the case of entries made with blue and green ballpoint pen and fountain pen inks (Fig. 6 Entry made with a fountain pen, not put through a laser printer – fifty times magnification; Fig. 7 Entry made with a fountain pen, put through a laser printer [visible blur of the ink] – fifty times magnification; see Polish version).
- disturbance of a line of writing after being put through a printer (Fig. 8. Entry made with a ballpoint pen, not put through a laser printer [ink location along the direction of the strokes of writing] – hundred times magnification; Fig. 9 Entry made with a ballpoint pen, put through a laser printer [inks location along the direction of the strokes of writing, irregular edging] – hundred times magnification; Fig. 10 Entry made with a fountain pen, not put through a laser printer [ink location along the direction of the strokes of writing] – hundred times magnification; Fig. 11 Entry made with a fountain pen, put through a laser printer [ink location along the direction of the strokes of writing, irregular edging] – hundred times magnification; Fig. 12. Entry made with a gel pen, not put through a laser printer [inks location along the direction of the strokes of writing] – fifty times magnification; Fig. 13. Entry made with a gel pen, put through a laser printer [inks location along the direction of the strokes of writing, irregular edging] – fifty times magnification; see Polish version):
  - location of the inks along the fibres of the paper, not along the direction of strokes of writing, in the case of entries made with blue, black and green ink ballpoint pens, fountain pen, felt-tip and gel pen;
  - irregular line edge caused as a result of the inks running off the paper fibres in the case of entries made with blue, black and green ink ball point pens, fountain pen, felt-tip and gel pen;
  - lack of clear "white lines" typical of the entries made with blue and black ballpoint pen inks.
- ink deposits off the line of writing (spatters) not resulting from the common process of writing, in the case of the entries made with blue and black ink ballpoint pens (Fig. 14 The entries made with a ballpoint pen, put through a laser printer (numerous inks spatters off the main line of writing) – hundred times magnification; see Polish).
- occurrence of partially fused surfaces, sinter, after passing through the printer, in the case of the entries made with a black ink felt-tip pen and a black paste gel pen (Fig. 15 Entry made with a ballpoint pen, put through a laser printer (visible sinter) – one and two hundred times magnifications; see Polish version).
- lacking relief, after being put through a printer, in the case of the entries made with blue, black and green ballpoint pen, fountain pen and a felt-tip pen inks; Fig. 16 Entry made with a ballpoint pen, not put through a laser printer (visible relief of the graphic line) – 3D image, fifty times magnification; Fig. 17. Entry made with a ballpoint pen, put through a laser printer (lacking relief of the graphic line) – 3D image, fifty times magnification; see Polish version
- change in colour of handwritten deposits after being put through a printer, in the case of the entries made with a fountain pen and a gel pen (Fig. 18 Entry made with a fountain pen, put through a laser printer (visible chromatism within the graphic line) – hundred times magnification; see Polish version).
- presence of toner particles on the entry surface after passing through the printer (Fig. 19 Entries made with a ballpoint pen, put through a laser printer – five hundred times magnification; Fig. 20 Entry made with a ballpoint pen, put through a laser printer – 3d image, two hundred times magnification; see Polish version).

Typical features of the entries put through a laser printer involve the following: inks, substrate, time between making entries and putting them through a laser printer, age of the document and the laser printer (type of device, time in service, toner type). Examinations aimed at establishing the dating of non-intersecting personal handwritten entries and laser print should be carried out in different microscopic

Table 1

Typical features of the entries put through a laser printer

Seq. No.	Typical features of the entries put through a laser printer	Type of inks	Notes
1.	Blurred ink also seen outside the line of writing	blue ink ballpoint pen green ink ballpoint pen fountain pen	
2.	Inks location along the paper fibres, not along the direction of writing strokes	blue ink ballpoint pen black ink ballpoint pen green ink ballpoint pen fountain pen felt-tip pen gel pen	
3.	Irregular edging of written deposits	blue ink ballpoint pen black ink ballpoint pen green ink ballpoint pen fountain pen felt-tip pen gel pen	
4.	Lacking clear “white lines”	blue ink ballpoint pen black ink ballpoint pen	in the case of using less contrast ballpoint inks, for example, a green one, lacking “white lines” may not be noticeable
5.	Ballpoint ink deposits located off the line of writing, not resulting from the common process of writing	blue ink ballpoint pen black ink ballpoint pen	may occur in the entries, put through a laser printer, shortly after their completion
6.	The presence of partially fused surfaces – “sinter”	black ink ballpoint pen felt-tip pen gel pen	
7.	Change in colour of the written strokes	fountain pen gel pen	
8.	Lacking relief	blue ink ballpoint pen black ink ballpoint pen green ink ballpoint pen fountain pen felt-tip pen	relief disappears in the ageing process of the document
9.	The presence of toner particles on the surface of the ballpoint inks	all types of inks	very useful for the evaluation of this feature is a 3D image

magnifications (from fifty to five hundred times) in visible radiation. Not all the typical features of the entries put through a laser printer must occur simultaneously in the written entry. It is only the toner that is always present on the surface of the entry put through a laser printer, however, for entries made with blue and black inks, its identification may be more difficult. Therefore, in cases of doubt, no categorical conclusions should be made. The dating examination of non-intersecting handwritten entries and laser print indicates a subjective approach and depends on the experience of the expert and their visual perception. In case of doubt, it is recommended to carry out comparative testing using the same, generic means and materials (type and model of the printing device, paper weight, type of writing tool, type and colour of the inks) and, as far as possible, taking into account other factors related to the state and preparation method of the questioned document. It is desirable that comprehensive examinations should be performed based on both optical microscopy and spectroscopic research.

Source

Figure 1: http://www.pcformat.pl/laser-od-srodka,a,1412

Figures 2–4: instruction manual (electronic version) of Nikon Eclipse 80i microscope

Figures 5–21: U. Konarowska

Table 1: by the author

Translation *Ronald Scott Henderson*