An Instance of Inkjet Printer Identification

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Examination of a series of anonymous documents generated by inkjet printer technology, revealed the presence of several printing flaws. A suspect inkjet printer was received for examination. Test printing with the suspect printer reproduced the same flaws observed on the questioned documents. Examination of the suspect machine, and its test prints, resulted in isolation of "class" flaws and a previously unobserved "individual" printing flaw. The cumulative presence of these features enabled an association between the anonymous documents and the suspect inkjet printer.

Introduction

Unfortunately for the Forensic Document Examiner (FDE) seeking to determine whether a particular printer produced a suspect document, inkjet printers and their printed products often possess insufficient individual features upon which to base an identification. The relative simplicity of these systems, consistency in the manufacturing of their print heads, and the ease of print head replacement in many models, collectively produce few individual features. There is the additional complexity resulting from various manufacturers who employ the same print mechanisms for their inkjet printers with other machines, such as multifunction printers (MFP's). Respective print mechanisms are also supplied to other manufacturers and distributors, who in turn use all or part of these mechanisms in machines with their own label (Seiger, 1997). Numerous suppliers, offering savings of up to 90% over original equipment manufacturer (OEM) supplies, now provide compatible replacement ink cartridges, remanufactured OEM ink cartridges, and replacement bulk inks, which also complicate the task of associating inkjet printed documents with the machines that printed them.

Technical articles on inkjet printers generally suggest microscopic examinations (Oliver and Chen, 2000), alternative light source examinations and thin-layer chromatography to differentiate the many "class" features of the inkjet printed material (Lewis, Kondrat, 1997; Doherty, 1998). Trade journals and product review literature are additional sources of information regarding class features and potential class defects. In addition to nonfunctioning ink ports and alignment defects, the FDE must be alert to the presence of other "individual" features that may occur with inkjet machines and the documents they produce. Such was the case addressed in this paper.

Methods And Materials

The first questioned document in this case consisted of an anonymous threat letter printed by an inkjet printer on a single piece of bond paper. The second questioned document involved a threat letter printed by an inkjet printer on two pieces of lined, three-ring tablet paper. Materials submitted for comparison included a laptop computer, a Canon BJ-200ex inkjet printer, a partial packet of bond paper and a partial packet of lined three-ring paper.

All of the questioned notes were initially examined for indented writing with an Electrostatic Detection Apparatus (ESDA) manufactured by Foster and Freeman. No decipherable impressions were observed.

The default printing features, to include the margin settings, print style and size, line spacing, and left-side adjustment, were consistent between the questioned notes and samples initially printed with the suspect printer and laptop computer system. Examination of the suspect laptop computer memory revealed the text of a third threat letter later received by the victim.

This letter was not submitted for examination.

Examination of the printing on the first note revealed the presence of a recurring vertical ink smear near the center of the document (Figure 1). No vertical ink smearing appeared on either page of the second questioned note. Examination of the suspect printer identified the source of the vertical ink smearing to be a defective spring originally designed to function as an axle for the paper feed roller near the center of the printer (Figure 2). The loose spring was normally housed in the plastic superstructure of the printer. The adjacent paper feed roller and axle were absent (Figure 3).

Test printing with the suspect printer on bond paper produced vertical ink smearing that was consistent with the vertical ink smearing observed on the first questioned note. Test prints by the suspect printer on lined three-ring paper samples identical to the second questioned note, did not produce the vertical ink smearing observed on the unlined paper. The greater thickness of the bond paper (.004"/1.016mm, versus the lined paper at .003"/.762mm) seemed to be a possible factor causing the ink to be smeared by the spring. The greater amount of surface filler and sizing material on the bond paper might also have held the ink longer, thus facilitating smearing of the ink by the spring. Additionally, the bond paper's greater rigidity, versus that of the lined paper, might have increased the relative friction against the roller spring, thus contributing to the occurrence of the smearing.

Examination of the printing on the first note also revealed the lower extenders (descending strokes of letters y, g, p, etc.) were not fully printed

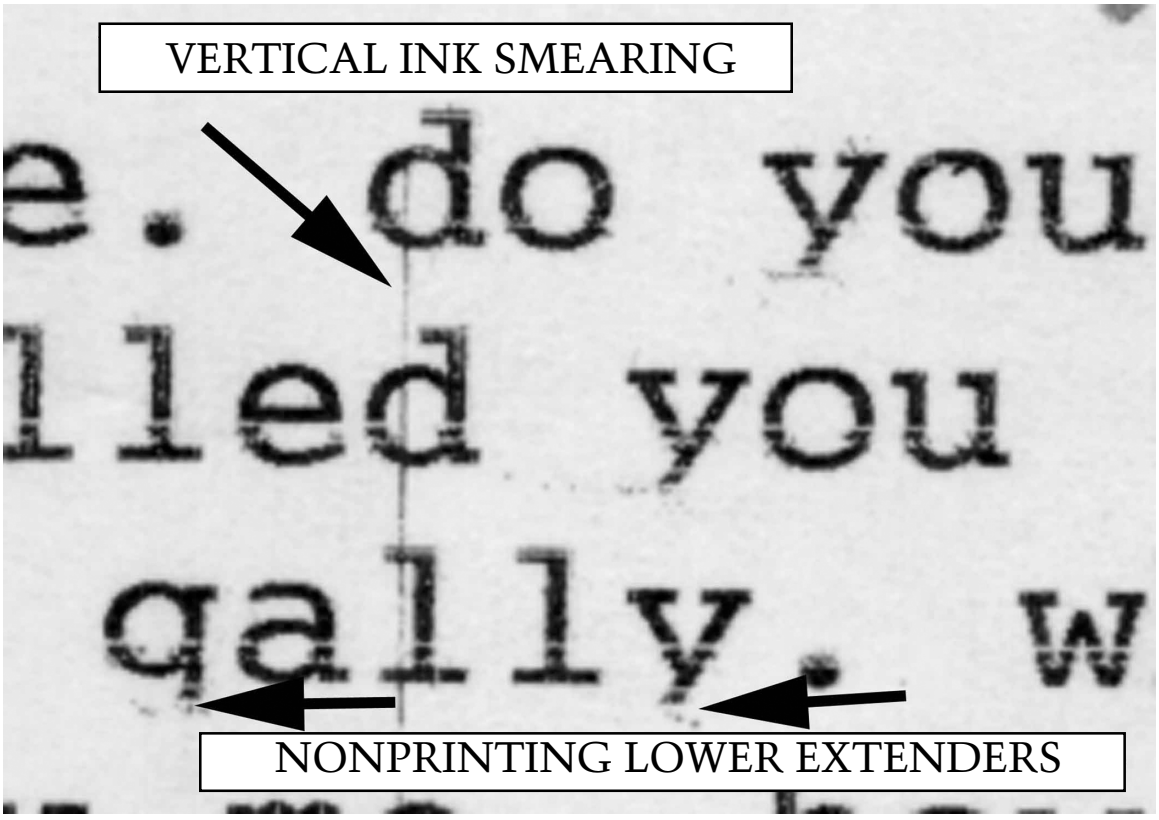

Figure 1. Note vertical ink smearing near center and nonprinting of lower extenders.

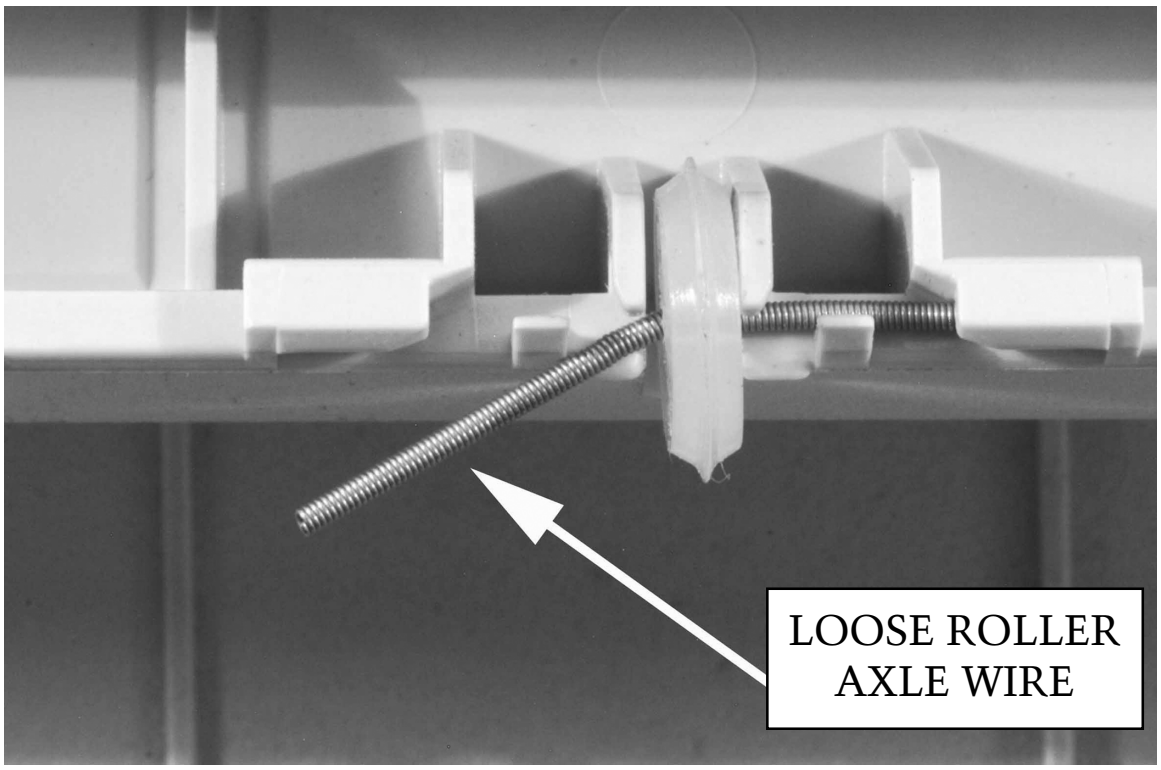

Figure 2. Note displaced paper roller spring axle that produced vertical ink smearing near the center of note #1.

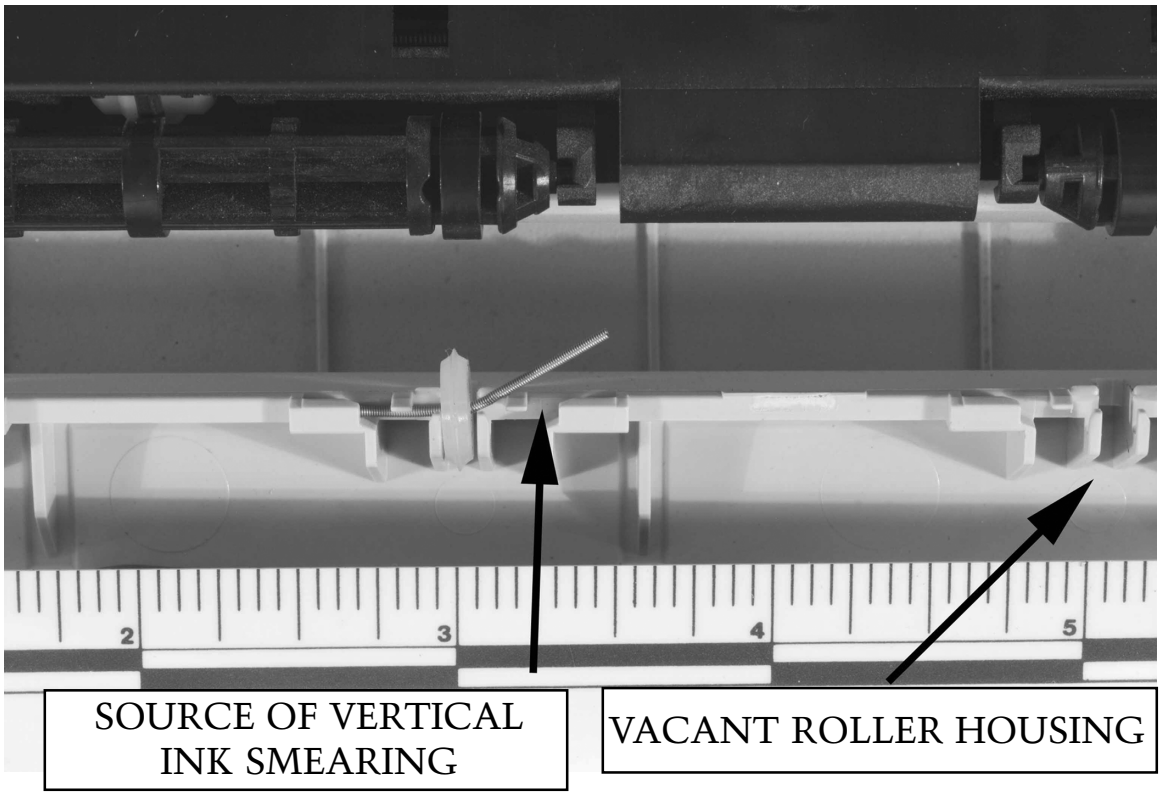

Figure 3. Note loose paper roller spring on left and vacant roller housing on right.

(Figure 1). The lower extenders were fully printed on both pages of the second note (Figure 4). Numerous test prints were made with bond paper and three-ring lined paper samples to monitor the occurrence of the print defect involving nonprinting lower extenders. Unexpectedly, the printer defect involving nonprinting lower extenders occurred randomly on both bond and three-ring lined paper samples. The random occurrence of this defect suggested it was not the result of thickness, rigidity, nor other aspects of the two papers used for the printer testing, as was theorized regarding the vertical line smearing. The source of this randomness could not be determined.

Nondestructive visual examinations and comparisons between the suspect bond paper samples and the paper comprising questioned note #1, revealed no differences. No individual features were observed that might have proved more definitive.

Nondestructive visual examinations and comparisons between the suspect packet of three-ring lined paper and the pages comprising questioned note #2, revealed no differences as to length and width dimensions and average thickness. Examination of the relative opacity, which was conducted with a Mead Corporation Opacity Comparison Test Chart, revealed no differences. No edge striation patterns were observed. The three-ring hole cuts were without notable individuality. Fortunately, printing defects were observed in the paper manufacturer's "faint lines" (horizontal blue lines and vertical pink left-margin lines, printed by a flexographic printing process) (Horton, 2001), on all of the three-ring paper in this case (Figure 5). The "faint line" printing defects were different between pages one and two of note #2. The packet of suspect lined three-ring

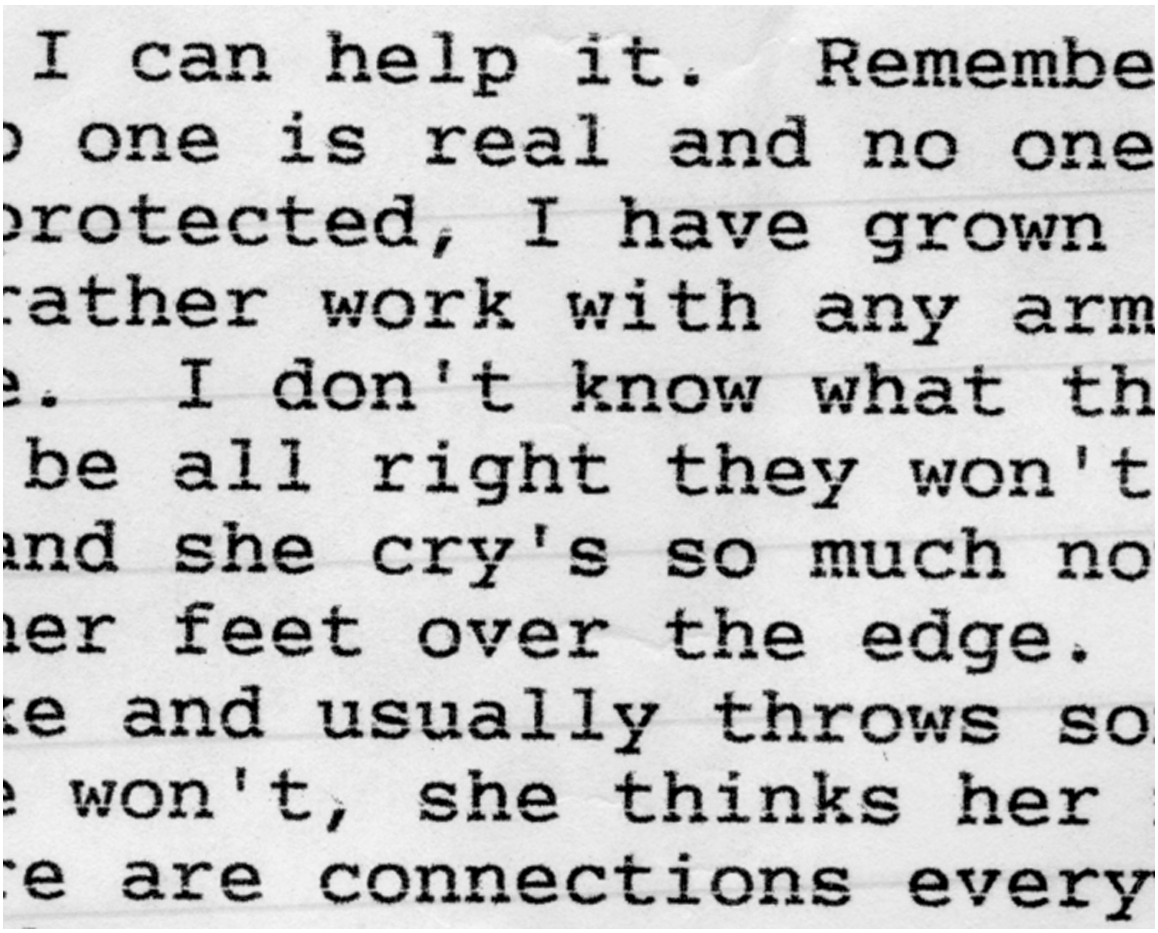

Figure 4. Note the absence of the vertical ink smearing and full printing of the lower extenders on note #2.

paper revealed alternating subsets, each with "faint line" defects. This indicated that the assembly of each package of paper involved interspersing paper from two sources. The numerous "faint line" defects on the two pages of note #2 corresponded precisely with the defects on respective alternating pages in the suspect packet of three-ring lined paper, thus confirming that they were all printed and assembled during the same production run.

Discussion

The defective spring axle from the paper feed roller on the suspect printer produced vertical ink smearing on bond paper test samples that was consistent with the vertical ink smearing observed on the first questioned note. Although it is not impossible that a second machine could suffer identical damage to this paper feed roller housing, the likelihood of its occurrence in a similar machine connected with this case seemed remote. Utilizing the ASTM conclusion scale (1996), the examination report stated, "there is the high probability the suspect printer was used to print the first note."

The absence of the vertical ink smearing on the second questioned note, comprised of three-ring lined tablet paper, was consistent with test prints made by the suspect printer on identical lined tablet paper. Physical differences between the bond and lined tablet paper (i.e., thickness, sur-

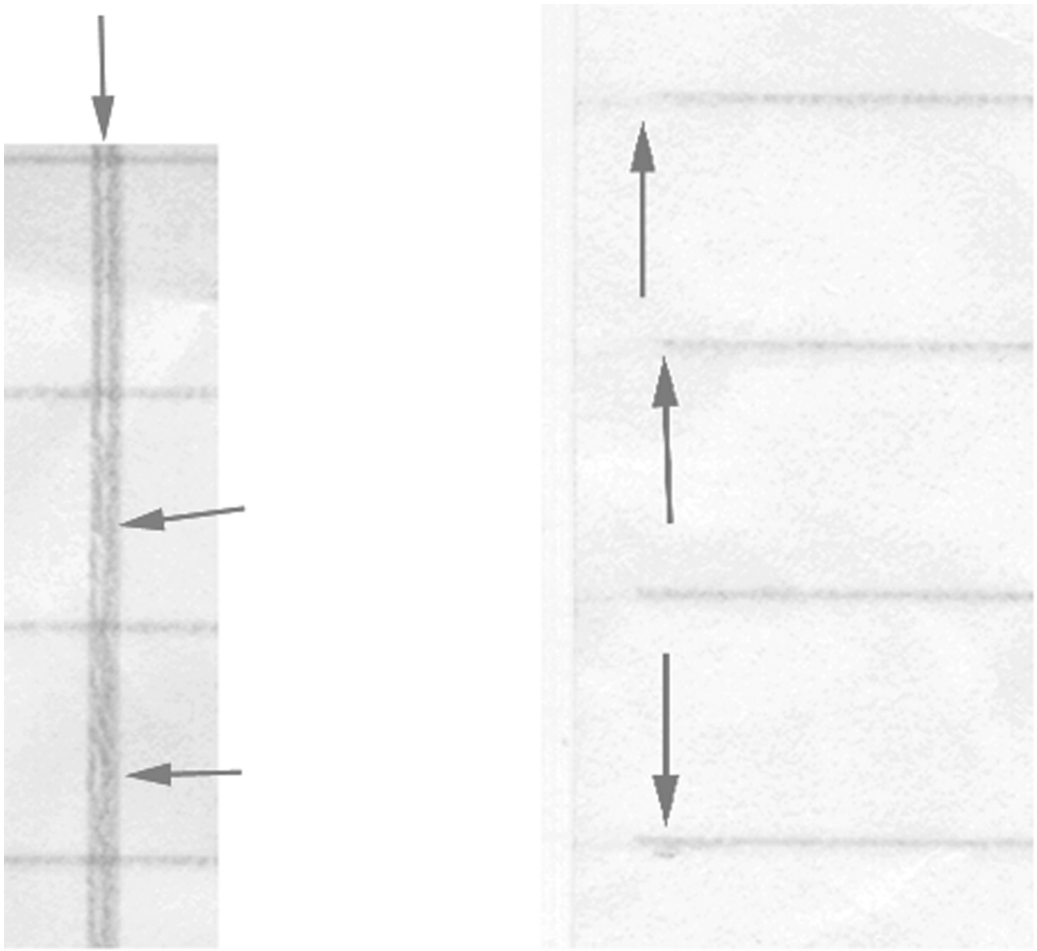

Figure 5. Note the "faint line" printing defects in the center of the vertical pink line (l) and at the left end of the horizontal blue lines (r).

face sizing/filler materials, rigidity, surface ink absorption rate, etc.) were the logical reasons for the presence or absence of the vertical ink smearing on these two paper types. The examination report stated, "no determination could be made as to whether or not the suspect printer produced the text of the questioned letter #2."

Manufacturer "faint line" printing defects appearing in the three-ring lined paper comprising the second note were identical with those present in the suspect packet of lined paper. The examination report stated "the suspect packet of paper, or another packet of paper manufactured at the same time during the same production run that produced the suspect packet of paper, was the source of the paper comprising questioned note #2."

It is critical to note the unexpected nature of the variation in the printing and nonprinting of the lower extenders by the suspect printer. Where the first note had the vertical streak and did not print the lower extenders, and the second note had no vertical streak and printed the lower extenders, it would have been a logical assertion that these differences indicated different machines. Or, at a minimum, that the notes might have been printed when the machine was in a different state of repair. Having the printer and printing numerous samples with the two different types of paper (bond and lined tablet paper) allowed verification of this particular variation in this machine. Absence of the printer for test printing might have led to incorrect interpretations of the evidence.

This examination confirmed the inestimable value of acquiring and testing suspect machines and paper samples whenever possible.

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