CASE REPORT

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Sentence Insertions Detected Through Ink, ESDA, and Line Width Analysis

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ABSTRACT: Four original construction reports were submitted to the U.S. Secret Service Forensic Laboratory for ink analysis. The documents were dated October 1984 through November 1984. The pages contained a government inspector's handprinted entries pertaining to an accidental death of a contractor in 1984. The investigator in this case suspected the construction inspector of falsifying government documents.

KEYWORDS: questioned documents, ink analysis, line width

Four documents (Exhibits Q1 through Q4), each consisting of two pages were submitted for examination. The first page of each document consisted of multiparagraph entries (Fig. 1). The question raised was whether the entries appearing in the "REMARKS" section of the first page were all written during the same time frame or whether portions were added later. For purposes of our examination, the entire document was considered to be questioned.

First, a physical analysis of the documents for indentations was performed [*1–3*]. Indentations are sometimes created by the transfer of pressure of the writing instrument, to underlying pages, resulting in depressed or indented areas on the surface of lower pages. When oblique lighting failed to reveal impressions on these documents, the electrostatic detection apparatus (ESDA) was used. Analysis using the ESDA revealed impressions on the second pages of documents Q2 and Q3. In each case, the impressions were caused by a portion of an entry found on page one of the same document. On these two Exhibits, the final sentence or paragraph under a section entitled "REMARKS" appeared indented on page two. The remaining portions of those pages did not show impressions on page two.

Analysis of the writing inks began with a microscopic examination of the ink lines [*4*]. This was done in order to determine the type of ink and writing instrument. All the areas in question were produced with nonballpoint pen(s). Further analyses of the inks using

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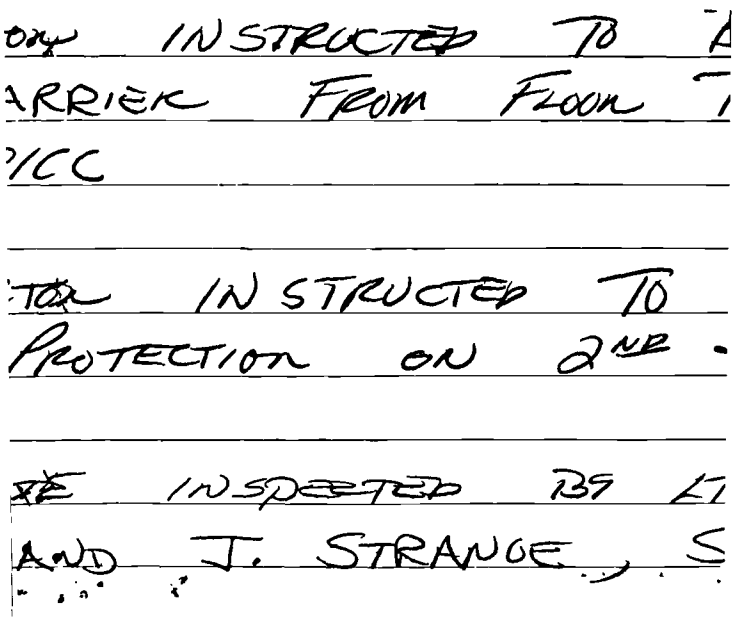

FIG. 1—*Photograph of the "REMARKS" section of Exhibit Q1.*

ultraviolet radiation and an infrared converter revealed the inks did not fluoresce in the UV region and their absorbance and luminescence qualities were similar. The inks were then chemically analyzed using the conventional methods for ink analysis [5]. It was determined that the inks in the questioned entries were all of the same dye composition.

Although the inks were consistent with being the same formula, certain paragraphs appeared visually different. The ink strokes in the final sentence or paragraph of each of the four documents appeared different from the remaining entries. Close visual and microscopic analysis indicated that the ink lines in those entries were thinner than the ink lines in the sentences which preceded them. An attempt was made to quantitate and illustrate this difference.

Line Width Analysis

Given the same formula of ink, there are a number of factors that may give the ink line a different appearance. The use of different nibs, a difference in the pressure applied while writing, and different writing surfaces can alter the appearance of an ink line. These changes may alter the line thickness, the line intensity, or both. Furthermore, the age of an ink line may alter its visual appearance. In an attempt to measure and record the differences of the line thicknesses, an image enhancement system was applied [6]. The instrumentation used allowed image processing with an IBM AT computer, QUANTEX QX7 software, and a camera attachment with a 50 to 200 mm lens. Using this system, images of the ink lines were enlarged to such an extent that measurements were easily taken.

First, the system was calibrated. To maximize the results obtained, one half inch (1.270 mm) was assigned 5000 units. The entries in question all consisted of upper case hand-printing. To limit inconsistencies resulting from writing block style at various angles, only nonretraced vertical line strokes were examined. An example of these strokes would include the base of a "T," an "I," or the downstroke of the base of an "R" or "F." All

of the vertical strokes in each sentence were measured. Approximately 20 strokes were measured in each sentence and the results were averaged. The width of the strokes was measured in calibrated units near the middle of each stroke and the results were recorded. The following is the average measurement in units (5000 units = 1.270 mm) for the width of the vertical strokes found within each sentence:

Exhibit	Sentence 1	Sentence 2	Sentence 3
Q1	216	220	187
Q2	217	198	
Q3	220	181	
Q4	197		

These results are further illustrated in Fig. 2.

Conclusions

The final sentence in each Exhibit was consistently thinner than the preceding sentence(s). With regard to Q4, the whole entry was thinner. The four final sentences (there was only one sentence in Exhibit Q4), when compared to all the other sentences, differed in width by an average of 27.5 units. Converting this to millimetres, it can be said that the line strokes in the final sentence(s) averaged .07 mm thinner than the sentence(s) which preceded them. Based on the width differences of these entries and the indentations developed, it was determined that, even through the ink formulas were the same, the

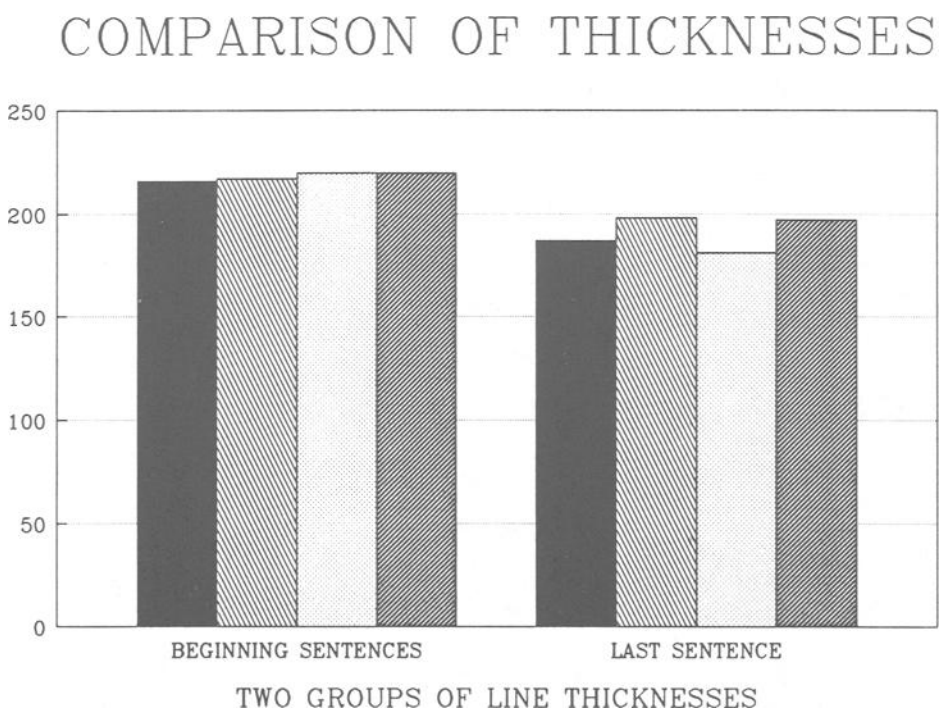

FIG. 2—*The "beginning sentences" represent Exhibit Q1 sentences 1 and 2, Exhibit Q2 sentence 1, and Exhibit Q3 sentence 1. The "last sentences" represent Exhibit Q1 sentence 3, Exhibit Q2 sentence 2, Exhibit Q3 sentence 2, and Exhibit Q4 sentence 1.*

last sentence(s) had been written at a different time, under different conditions and/or with a different writing instrument from the rest of the documents.

References

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