

1950

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Recommended Citation

Ordway Hilton, Pitfalls in the Use of Ultraviolet Examinations to Differentiate between Writing Papers, 40 J. Crim. L. & Criminology 519 (1949-1950)

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PITFALLS IN THE USE OF ULTRAVIOLET EXAMINATIONS TO DIFFERENTIATE BETWEEN WRITING PAPERS

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Examination under ultraviolet radiation has been recognized for some years as a means of differentiating between writing papers made of different kinds of fibers.¹ Chemical wood pulp paper, for example, fluoresces differently than cotton rag paper, and examiners of questioned documents have rather generally looked upon variations in color and quality of fluorescence between two specimens of paper as indicating a difference in composition and therefore a different source or time of manufacture. In a document of several pages, if one page fluoresces unlike the remainder, this fact has been accepted by some workers as an indication that the page had been substituted. The accuracy and reliability of this test has been investigated experimentally and is reported upon in this paper.

Investigation into this problem was prompted by questions raised at the 1948 meeting of the American Society of Questioned Document Examiners. A major portion of this annual meeting was devoted to the discussion and investigation of writing paper identification problems. The sessions were held in Appleton, Wisconsin, where members of the Society and key personnel on the staff of the Institute of Paper Chemistry conducted a joint seminar on methods of paper identification. The Society members also made a special inspection tour of two writing paper mills in that city.² One of the questions discussed at the seminar was the reliability of ultraviolet fluorescence as a means of differentiating between sheets of writing papers. Staff members of the Institute of Paper Chemistry pointed out the limitations encountered in their investigation of the subject. Furthermore, certain trade practices observed at the paper mills also suggested that the accuracy of ultraviolet tests might

¹ See Elbridge W. Stein, "Ultra-Violet Light and Forgery", *Scientific American*, 147(4):204-6 (Oct. 1932).

² The mills visited were the Fox River Paper Corp. and the Riverside Paper Co.

not have been investigated far enough. The entire discussion raised one basic question which had not been satisfactorily answered: Could a difference in ultraviolet fluorescence between two sheets of the same brand of paper necessarily mean that they did not come out of the same box?

MILL AND TRADE PRACTICES

In attempting to answer this question the methods of manufacture and distribution of writing paper become important. The manufacturing process itself is the obvious starting point. It is assumed that the reader is familiar with the Fourdrinier machine and its operation. This is the machine which is used in this country to make most writing papers. After the paper web comes off the dry end of the Fourdrinier machine it is wound on a reel in a large continuous roll. These rolls are made up of a run of one to one and one-quarter hours of paper making, depending on the particular mill and consequently contain thousands of feet of paper.³

Before the writing paper is shipped from the mill it may be cut into large sheets and packaged into ream units. The wide rolls which are taken off the paper machine are generally cut into narrower widths in a rewinding process before sheeting. A common type of sheeting machine in use today can be fed from as many as ten rolls of paper simultaneously, cutting the paper into the individual sheets and stacking them. Counting is done by an employee who operates the machine. With a machine of this kind feeding ten rolls at once, it may be that only every tenth sheet comes from the same machine run.

When these large sheets are packaged, they are shipped to stationery firms who cut them into the common commercial sheets, such as letter and legal size, and box or repackage them. These are the packages and boxes sold by the retailer. Without any mixing of lots during this last operation—a rather unlikely happening with the type of cutters used—the sheets of paper that are found in a retail box may well represent an assortment from as many as 10 different mill runs.

The entire question now resolves itself into how uniform the paper composition is held during ten consecutive machine runs. Interrogation of mill superintendents and chemists at the plants reveals that the person supervising the run determines the composition of stock within certain limits. Corrections may be made

³ The usual speed of paper making in a writing paper mill is from 300-500 feet per minute.

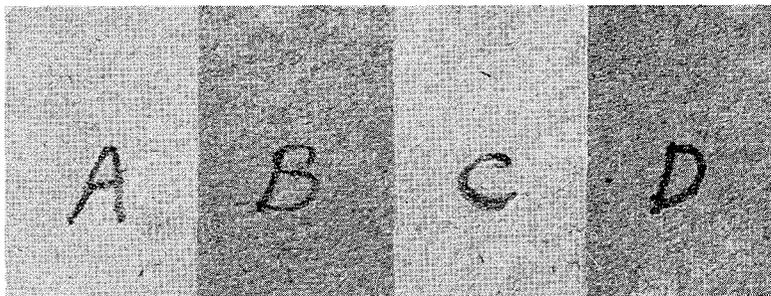


Figure 1.

Four sheets of Engraver's Parchment writing paper were photographed under ultraviolet radiation. The sheets are arranged in the order in which they were drawn from the box. Not only is there a difference in the intensity of fluorescence, but there is also a variation in color. Samples A and C showed blue-grey in tint; B and D, purplish. (Enlargement 2X. Corning 986 filter over mercury vapor lamp source. No filter over camera lens.)

from time to time in color, bleach, brightness, loading materials, sizing, and the like. These decisions are based upon his experience and the appearance of the paper as it comes off the machine. In the 10 to 12 hours necessary to make the paper at least two shifts would have handled the various runs. Over this period of time it is always likely that slight changes in composition may be made. Thus, all sheets in a retail box need not have been made absolutely identical, and, consequently, their fluorescent qualities may be affected.

EXPERIMENT

In order to test the reliability of ultraviolet fluorescence as a means of differentiating between two sheets of the same brand of paper, and especially to check on the uniformity of the fluorescent quality of successive sheets from the same box, a series of tests were made on different brands of rag content writing paper.⁴ 15 consecutive sheets were taken at random from the box, and successive sheets were compared under ultraviolet radiation. A Corex 986 ultraviolet filter was used over the mercury vapor generator to eliminate the visible light. Examination was made visually in order to duplicate the exact conditions under which the preliminary ultraviolet inspection of disputed papers are made.

With two brands the quality of fluorescence was not the same for all sheets, although the majority of papers tested showed

⁴ Papers tested were: Ebac Linen Bond (John McCabe & Co., N. Y. C.); Spencer Bond; Strathmore Parchment, 100% rag content (Strathmore Paper Co., W. Springfield, Mass.); Old Treaty Bond (W. C. Hamilton & Sons, Inc., Miquon, Pa.); and Engraver's Parchment (Southern Paper Co., Inc., Birmingham, Ala.).

no appreciable variation in fluorescence between successive sheets.

The most pronounced difference between sheets was found in Engraver's Parchment letterhead paper. Not only did the intensity of fluorescence vary from sheet to sheet but also the color. Some sheets showed a characteristic purplish fluorescence when subjected to ultraviolet rays while others appeared lighter and more nearly grey-blue in color. In all the differences were conclusive. A second sample from another box of the same paper, purchased at the same time as the first, substantiated these findings. After this preliminary visual inspection an ultraviolet photograph was made and is reproduced in Figure 1.

The results of tests on Spencer Bond were less pronounced, but still significant. All sheets fluoresced the same color, but there was a gradation in the intensity, some being darker than others. This difference seemed somewhat more in keeping with slight changes that might be made in the course of several mill runs. No attempt was made to record the difference photographically.

CONCLUSIONS

From this investigation it would appear that trade practices in the writing paper industry can bring about packaging of consecutive sheets of paper from different mill runs. Some runs may produce paper which show different fluorescent qualities from other runs in the same package. In the brands examined this condition was found in two instances, but it was not true with all papers tested. It would seem reasonable to conclude therefore that a marked difference in fluorescent qualities of two questioned sheets need not necessarily mean that one must have been substituted in the document subsequent to its preparation. Unless it can be shown from a representative sample of paper from the supply in use when the document was prepared, or there is other evidence to substantiate a conclusion of substitution, it is entirely possible that the two sheets originated in consecutive order in the same box. In the light of this investigation conclusions drawn from differences in ultraviolet fluorescence of writing paper must be interpreted with caution.