Linda J. Hart,[1] *B.A. and Brian B. Carney,*[2] *A.Sc., B.A.*

Typewriting Versus Writing Instrument: A Line Intersection Problem

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ABSTRACT: It may be possible to answer the question of whether or not a document was signed in blank, or after typing, by a microscopic examination of the line intersections. By removing the typewriter carbon at the point of the intersection, it can be clearly seen whether there is ink under the carbon or if the ink was removed with the carbon. A technique for determining the sequence of typewriting and most types of inked entries was developed. The results may be recorded photographically and subsequently used as a demonstrative exhibit in presenting the evidence during trial.

KEYWORDS: questioned documents, typewriters, intersecting lines, signatures

In the business world, the documents produced are most frequently typewritten on a machine using either a correcting black carbon ribbon or a permanent black multi-strike ribbon. The correcting type of ribbon is usually found on a conventional typewriter such as the IBM Selectric; the high-yield, multi-strike carbon ribbon is encountered in word processors, where typographical errors can be corrected before the actual printout. These typewritten documents are then signed or initialed in some manner, using a wide variety of writing instruments including ball-point pens, felt- or fiber-tipped pens, roller-ball pens, erasable ball pens, and, occasionally, pencil. During the course of examination of these documents, questions frequently arise as to which came first—the typing or the writing.

Much has been written in the scientific literature concerning "sequence of strokes" involving both homogeneous and heterogeneous writing instruments and varied writing instruments with typewriting. The literature consistently refers to this as one of the most difficult problems facing the examiner of questioned documents. The problems involving optical illusions are addressed in almost every article written. It is recognized that the darker writing or impression consistently *appears* to be on top of the lighter writing medium. In cases of line intersections there is a tendency to see what one perceives to be the correct sequence. Furthermore, the authors of these various articles frequently refer to the need for the document examiner to train himself or herself through controlled tests before attempting to reach a conclusion as to the sequence of entries in an actual case.

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[1]Questioned document examiner, Hart Questioned Document Laboratory, Inc., Miami, FL.
[2]Examiner of questioned documents, Lawrenceville, GA.

Overcoming perceptual problems and insuring accurate and replicable results was the thrust of this research. Is it possible to produce an objective test which eliminates experimenter bias and the problems of perception in determining the sequence of entries?

As an offshoot of actual case inquiries, Examiners Brian Carney of Lawrenceville, Georgia, and Linda Hart of Miami, Florida, each began independent research projects to determine with what degree of accuracy and under what circumstances the sequence of typewriting and writing intersections could be determined. It was only at the conclusion of the research conducted by each examiner that they became aware of each other's endeavors and decided to collaborate in the presentation of their results.

Methods and Equipment

The two examiners set up a series of blind tests in which a different individual prepared and recorded the sequence of intersections. Both examiners limited their work to the carbon lift-off ribbon and the multi-strike carbon ribbon. Both used three grades of paper stock: the lowest was a pulp paper with no sizing, the next higher was a 25% cotton bond, and the last was a highly coated, erasable bond paper with a noticeably slick finish. The writing instruments used included blue, black, and red ballpoint pens, felt-tipped or fiber-tipped pens, and roller-ball pens. In addition to this, Carney included carbon or graphite pencil as an additional writing medium. Both examiners also included blue and black erasable ink in each phase of their research.

Carney and Hart both approached the problem in a similar manner. Carney attempted to determine the sequence of intersecting lines by abrading the trough at the intersecting point of the carbon font impression and the writing line with a 27-gage insulin needle. Under magnification ($\times 20$), the paper was positioned at a comfortable working angle to the strong hand. The *side* of the needle point was placed adjacent to the right edge of the intersection and moved from right to left across the font trough (opposite direction depending on strong hand). This motion was repeated *without* downward pressure (the needle did the work) until most or all of the carbon was removed. The trough area was not abraded vertically since that was found to damage extensively the paper fiber in some cases.

Hart's approach to the problem was similar in that she used a scalpel blade to flake off the carbon particles at the point of an intersection. Her assumption was also similar to that of Carney; she believed that in areas where the typing was done first there would be an absence of ink, while ink would be present under the carbon when the writing was done before the typing.

Both examiners encountered some difficulty in terminology. Numerous mistakes were made when recording the results as "ink over typing" or "typing over writing," there being a tendency to confuse the "over/under" statement. To resolve this, Carney used the "first/second" statement in reporting his findings. Hart, similarly, found that such labeling was less confusing and eliminated the majority of errors caused by terminology. Thus the results of each examination would be "ink first/typing second" or "typing first/ink second."

Both Carney and Hart used one additional method in their testing involving an adhesive type tape. Carney used a clear adhesive tape, which he placed over a point of intersection. Using a stylus he then rubbed the area of the intersection. After lifting the tape, he would examine the area microscopically to determine if any ink residue remained undisturbed on the paper.

Hart used an IBM lift-off ribbon which is opaque and significantly more tacky than the clear cellophane tape. She also used a stylus, with the document placed on a transmitted light box, and exerted pressure over the point of an intersection. She then examined both the tape and the paper microscopically to determine if an undisturbed ink line was

present on the paper or if the ink had been transferred along with the carbon to the tape. The latter was presumed to occur if the typing were first and the ink second.

Results and Discussion

Both Carney and Hart began their research by conducting a limited, blind experiment. Both reported that the initial attempts to determine sequence resulted in approximately 20 to 25% errors. Both used the results of the initial tests as a means of learning which characteristics to look for when conducting subsequent tests. They are of the opinion that such a learning period with a series of blind tests is absolutely essential to future accuracy in making determinations. The preliminary test produced by Mr. Carney as a learning aid is reproduced in Fig. 1.

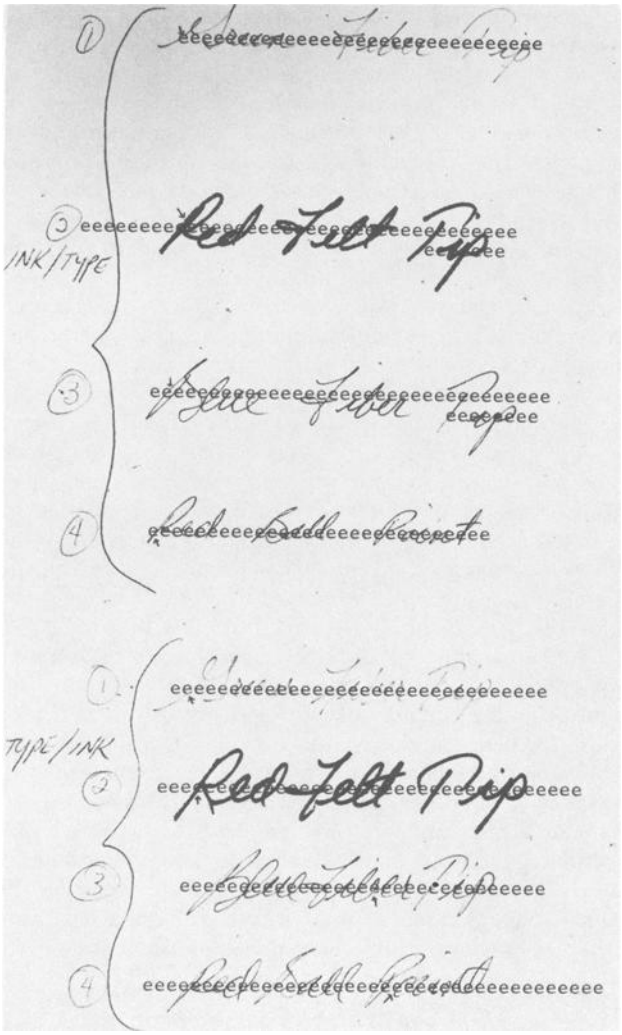

FIG. 1—*Example of trial test used for learning purposes.*

After the initial training or learning period, both examiners reported identical findings when completing subsequent test problems. First, it is possible to determine in advance which problems *cannot* be resolved with any degree of reliability. Second, it is possible to determine accurately the sequence of entries with specific writing media appearing on various grades of paper. These later findings are replicable and can be demonstrated in court.

It was generally agreed for the first finding that no conclusion should be rendered in cases involving broad marking pens on rag or unsized paper, although some exceptions were noted involving situations of typing first/ink second. The paper acts as a sponge, and the ink appears to penetrate the carbon barrier formed by the typewriting.

Therefore, a typing can be executed first, but an undisturbed ink line is still present on the unsized paper after the carbon is removed. This caveat does *not* necessarily apply to fine-point, fiber-tipped pens unless the writing is excessively slow, thereby allowing more penetration of the ink into and under the carbon on the paper. In these instances, the presence of ink under the typing should not be considered conclusive proof of ink first/typing second. However, the absence of ink can be considered conclusive proof of typing first/ink second even in the case of broad-tipped marking pens.

The next area in which significant care should be exercised is pencil or erasable writing ink and typing, because neither of these writing media is permanent but merely rests on the surface of the paper. The graphite or erasable ink is likewise removed in the act of abrading or removing the carbon. Therefore, in these instances the absence of ink or graphite should not be interpreted as evidence of typing first/ink second. However, if the erasable ink has sufficiently dried and an ink line is found after abrading the carbon, a conclusion of ink first/typing second is justified.

The second classification involves instances in which consistently accurate results were achieved by both examiners. Both examiners reported conclusive determinations in cases involving ballpoint and roller-ball pens of all three colors on all grades of paper. The high-yield multi-strike ribbon was slightly more difficult to work with because it required more abrasion, yet the end result was reported to be the same. The self-correcting ribbon was the easiest to work with because it rests on the surface of the paper and is easily removed, except in instances where heavy pressure from the pen nib "fixed" the carbon to the paper. This phenomenon in itself is conclusive evidence of typing first/ink second.

A caution is required even in these instances. Both examiners are of the opinion that more than a single point of intersection should be examined before rendering conclusive opinions. The multiple intersections need not be in more than one typewritten letter. For example, an ink line crossing through the right side of an uppercase "E" may provide three points for examination and a looped stroke through this letter a total of six points of intersection.

It is the opinion of both examiners that the most readily solved problems involve ballpoint pen writing, a correctable typewriter ribbon, and highly coated erasable bond paper. This combination of medium and paper also lends itself very well to the use of adhesive tape in making a lift at the point of intersection. However, only a highly coated paper is suitable for such an examination. The rag paper and standard 25% cotton bond papers are subject to significant fiber disturbance at the point of intersection. This is considered unacceptable due to the severity of damage to the document. The use of IBM lift-off tape does hold one advantage when used on a slick erasable bond—the ability to double-check results or provide two reference points in evaluating the sequence at the point of intersection. The paper itself can be examined microscopically, and the white, opaque tape may be examined as well.

Photomacrographs provide conclusive and irrefutable evidence of the results recorded during the examination. Although black-and-white prints are usually adequate as a demonstrative exhibit, color slides provide the most dramatic and persuasive exhibits.

Carney photographed his results on a Nikon Multiphot Camera System (Fig. 2) at ×20 magnification with transmitted light from a fiber-optic directed-illumination system. This lighting system provides focused light and eliminates the stray light encountered in standard transmitted-light photography. Figure 3 is a photomacrograph of five points of intersection through two typewritten letters. The abrasion or removal of the carbon clearly shows a broken writing line. This is conclusive evidence of typing first/ink second. During the removal of the carbon, the ink resting on the surface of the carbon was likewise removed.

Figure 4 is a photomacrograph of two points of intersection through the typewritten lowercase "i." Following the removal of the carbon from the typing, the ink line remains undisturbed.

Note that these tests, though providing conclusive evidence of sequence of entries, involve a destructive technique. As such, these tests should only be conducted after the appropriate authorizations have been obtained from the courts or attorneys involved. Before any such testing, the document should be photographed in its original state. Finally, if numerous points of intersection are present, the tests should be conducted on the fewest points necessary to arrive at a conclusion. This would allow for future testing by other examiners, should that be deemed desirable at some later date.

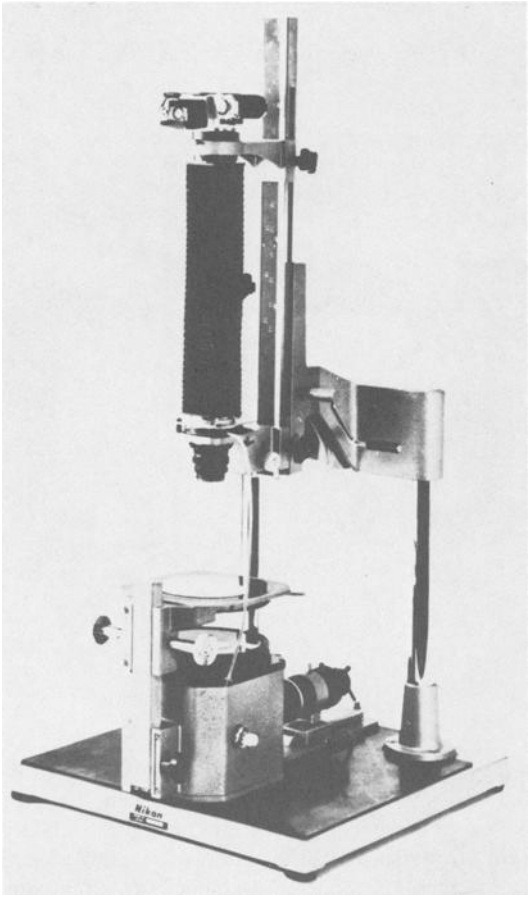

FIG. 2—*Nikon Multiphot camera system used by Carney.*

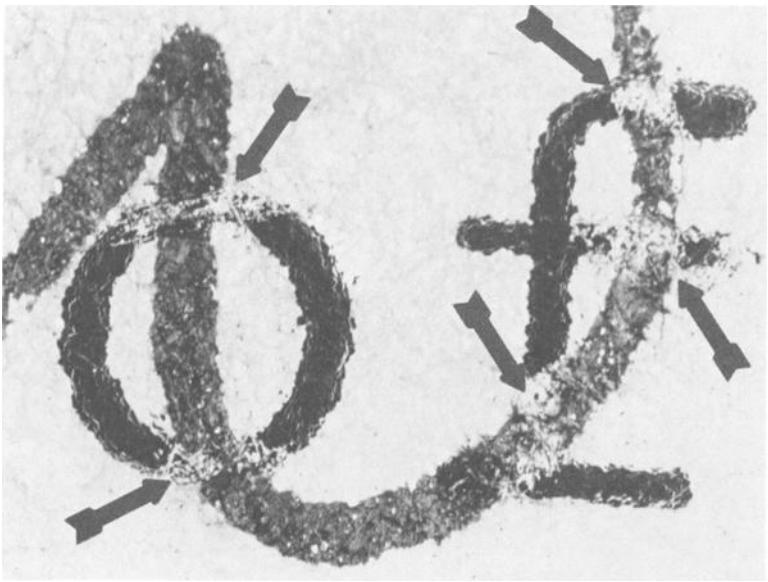

FIG. 3—*Photomacrograph of typing first/ink second.*

FIG. 4—*Photomacrograph of ink first/typing second.*

Conclusion

In the investigation of line-intersection problems involving carbon typewriter ribbon and ballpoint, roller-ball and fine-point fiber-tipped pens, it is possible to determine accurately the sequence of occurrence by careful abrasion or flaking of the carbon from the paper at the point of intersection. The results are replicable, eliminate experimenter bias and problems of perception, and can be demonstrated in court using photomacrographs. The technique is destructive in nature, and all precautions applicable to other destructive techniques such as ink analysis must be taken into consideration.

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Address requests for reprints or additional information to
Linda J. Hart
Hart Questioned Document Laboratory, Inc.
11420 N. Kendall Dr., Suite 206
Miami, FL 33176