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Determining the Sequence of Ball-Point Pen Writings—A New Method?

Examiners of questioned documents are frequently faced with the problem of determining the sequence of crossed lines. The answer to the question of line sequence can be of immense importance. To determine which of two intersecting pen strokes was made first may ultimately decide the outcome of a contested court case, or even negate the necessity of a trial. The disclosure of a cleverly perpetrated fraud or the sustaining of a genuine writing in controversy may result from such a determination.

Fraudulent documents are sometimes written above genuine signatures that were originally executed for some other purpose. The unauthorized addition of but a single handwritten stroke to an instrument has been known to increase the monetary value of that instrument many thousands of dollars. The interlineation of a single word, sentence, or paragraph to an official document may result in irreparable damage if gone undetected or unproven.

Background of Problem

That the problem of intersecting lines is a recurring one that requires the utmost caution on the part of the experienced document examiner has long been acknowledged by experts in the field. A review of the published literature in this problem area yields a consensus that mistakes are easily made and, as of yet, no method or technique has been discovered that will yield definitive results all the time.

Almost a half century ago, A. S. Osborn [*1*] stated that "under certain conditions it is not possible to tell which of two crossed lines was last made." Conway [*2*] also confirmed that "the determination of the sequence of intersecting lines of writing is not always possible where ball-pen writings are involved."

The English author Harrison [*3*] categorically refuted a time-honored procedure of determining line sequence where no ink flow had taken place at the intersection of the lines by declaring: "Working in this way, the observer can expect to be right in half of the cases he deals with, for this is the percentage of success achieved by guesswork!" Mehta [*4*], an Indian authority, stated that "it is not always possible to ascertain the sequence of strokes." Villanova [*5*], in his article on this same subject, quoted Hoffman, the German handwriting expert, on the question of intersecting lines of ball-point pens: "The cases in which this question cannot be solved—or only with the greatest difficulty—are so numerous that the expert always approached the problem with pessimism."

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A more recent authority, Godown [6], in his excellent article that dealt specifically with this problem, stated that "definite physical indications of writing sequence are not invariably present. Even though two writings touch at several points, it is not unusual to find that most points of contact provide no reliable evidence of the writing sequence." And, even with the innovative assistance of the scanning electron microscope, Williams [7] found that it was frequently impossible to determine which of the intersecting lines was uppermost.

This, then, is the state of the art today. As of present, there exists no one infallible method or technique of determining the sequence of crossed ball-point pen lines.

Discovery of Technique

An informative article written several years ago by Crown [8] cited a technique whereby a "sticky lifter, of the type used to lift latent fingerprints" was used to determine the placement sequence of an ideographic signature and the Han mark. The Han mark (commonly referred to by Westerners as a "chop mark") is normally used for authenticating a signature and it is similar to a rubber stamp in that it is inked and then pressed onto the document over the signature. Dr. Crown explained that questions frequently arose as to whether a Han mark was over or under a written signature. He further explained that if the Han was over the signature, the application of the lifter would allow the impression of the Han to be removed in its entirety. If, however, the signature was over the Han, the lift would disclose that the Han would be interrupted in each place by the superimposed ink line. Crown conjectured, in conclusion, that this technique might have some value in other sequence of stroke problems in this country.

It was Crown's final comment and suggestion that piqued the interest of this author. A number of questions immediately came to mind with respect to the adaptation of the Japanese method. Would a method similar to that used by the Japanese laboratories work with crossed ball-point pen lines? Could lifts be made of ball-point pen lines that would determine the sequence of their intersection? Was it possible that the top line might be visually portrayed as cutting the bottom line? If so, would it work every time or only occasionally?

Crown's article had been read at home and some handy materials were pressed into service in an initial attempt to answer some of these questions. Available in the author's residence were several ball-point pens, some 102 by 127-mm (4 by 5-in.) cards, and a roll of transparent cellophane adhesive tape. To simulate a line sequence problem, intersecting lines were drawn on the cards and sequentially numbered. A section of tape was then carefully pressed onto the card, covering the intersection of the two lines, and then the tape was slowly removed. To provide an adequate viewing background for the examination of the lift, the tape was restuck to a second card. The results were unmistakable. Even without the assistance of a magnifier, it was obvious that the top (second) line cut the bottom (first) line. There was no question as to which line had been drawn last.

Results and Discussion

The results of the lift of two intersecting lines are shown in Fig. 1*a*. As can be observed, the lift picks up the exterior boundaries of the ink lines and, at their intersection, only one of the lines appears continuous and uninterrupted. This unbroken line is the second or last line and it actually cuts the path of the initial stroke.

In comparing the lift outlines of the intersecting strokes in Fig. 1*a* with the photograph of the acutal lines from which the lift was taken (Fig. 1*b*), it is observed that Line 2 was drawn last. (It should be noted that the numbering of the lines on Fig. 1*b* depicts the actual sequence in which they were placed on the card. This sequential numbering system

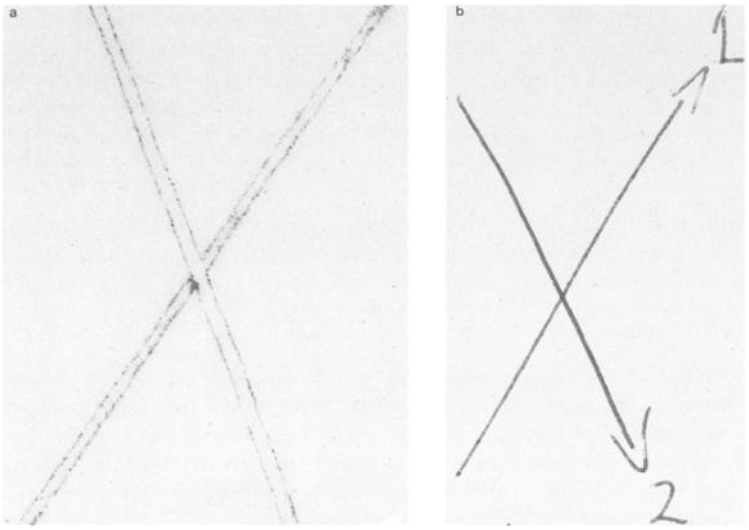

FIG. 1—(a) *Lift of two intersecting ball-point pen lines. Note that ink outlines of line extending from upper left to lower right appear to cut the other diagonal line.* (b) *Actual lines from which the lift in* (a) *was taken. Line 1 was drawn first and Line 2 was drawn last.*

holds true for subsequent figures. The arrows at the line endings reflect the actual direction of movement). A graphic portrayal of the line sequence depicted in Fig. 1*a* is shown in Fig. 2.

Various ways of placing the tape and lifting it from the document were tried to obtain the optimum results. It was determined that if an insufficient amount of pressure was applied the resultant lift was too light and frequently indiscernible and would, therefore, fail to depict any line sequence. Additionally, if the pressure applied was excessive the lift would not only pick up the ink outline but would also remove the ink from the bottom of the trough created by the ball of the pen. Excessive pressure also gave inconclusive results. The best results were obtained with moderately applied pressure obtained by lightly placing the tape over the crossed lines and then rubbing the thumbnail evenly back and forth over the tape surface.

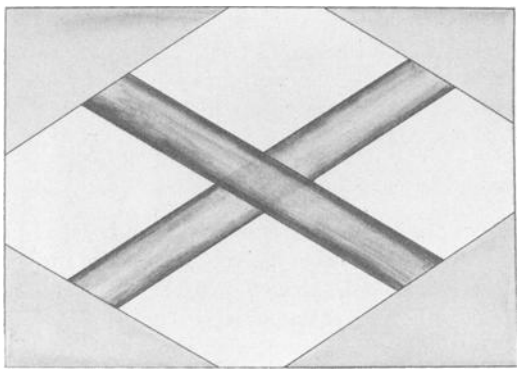

FIG. 2—*Drawing of intersecting lines protraying the second line cutting the first line. Heavily shaded exteriors of lines depict ink outline picked up by the tape* (*see Fig. 1*).

Figure 3*a* shows the results of a lift from three intersecting lines. Using the observations and reasoning principles applied to the intersection of the two lines portrayed in Figs. 1*a* and *b*, the reader should be able to determine correctly the sequence of the three line intersections. Figure 3*b* is a photograph of the intersecting lines from which the lift was made and it depicts the actual sequence (that is, Line 1 was drawn first, Line 2 was drawn next, and Line 3 was drawn last).

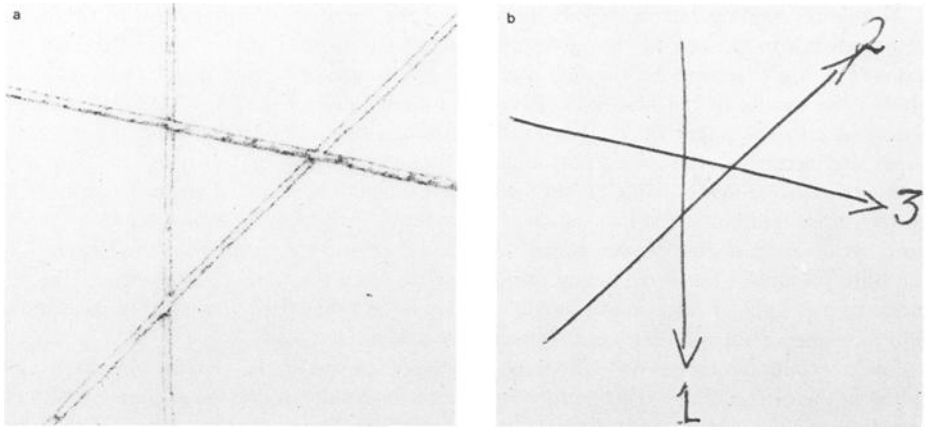

FIG. 3—(a) *Lift of three intersecting ball-point lines.* (b) *Actual lines from which the lift shown in* (a) *was made.*

A lift made from the intersections of four lines is shown in Fig. 4*a*. Again, the correct determination of line sequence can be made. The true sequence is shown in Fig. 4*b*.

Additional experimentation with this technique of ascertaining intersecting line sequence of ball-point pen strokes resulted in a number of additional determinations. Although a variety of fingerprint lifting materials were tried, none appeared to work as well or as consistently as did the transparent cellophane adhesive tape. No distinct advantage was observed between the several different brand names of this type of tape that were tested.

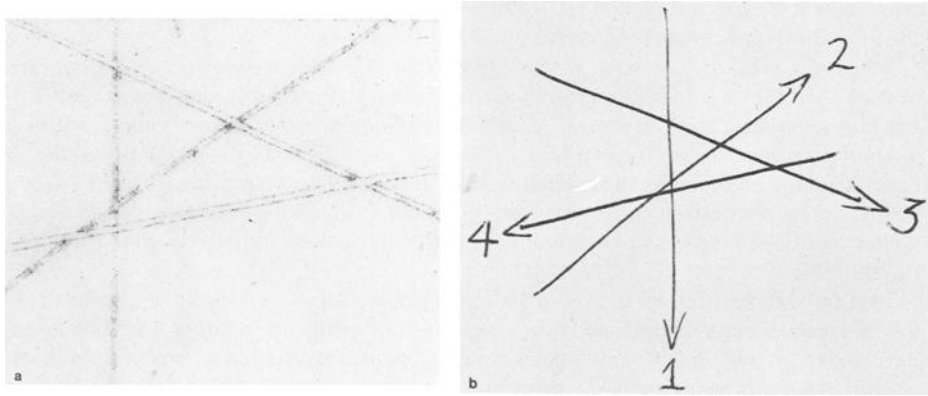

FIG. 4—(a) *Lift of four intersecting ball-point pen lines.* (b) *Actual lines from which the lift shown in* (a) *was made.*

The surface of the paper upon which the ink lines were drawn also proved to be a variable with respect to the quality of the lift. Normal writing paper proved to be acceptable if care was taken in applying and lifting the tape so that the paper fibers were not removed also. Papers with loose surface fibers (such as mimeograph and poor quality writing and typing papers) did not withstand the adhesive qualities of the tape and were therefore unacceptable. In general, good quality typing and writing papers were found to yield favorable results from which correct determinations of line sequence could be made.

Additional limiting factors of this technique were found in the properties of the ball-point pen ink used to make the intersecting lines. The fluidity of the ink and the actual amount of ink deposited by the ball onto the paper surface proved to be variables that altered the results of the tape lifts. Passage of time caused the ink to dry and become absorbed into the paper fibers. For example, it was determined that when index cards were used acceptable lifts were not obtained beyond a period of 1 h from the time the crossed lines were made. After 1 h an insufficient amount of ink adhered to the tape for a correct interpretation of the line sequence. Frequently, even less time was required before no determination of line sequence could be made. It was suspected that the amount of moisture present in the surrounding atmosphere and the position of the document in relation to any light or heat source would also alter the rate of ink drying and absorption into the paper, although this was not specifically evaluated.

Another limiting factor was discovered during experimentation which ultimately resulted in the discrediting of this method for attempting to determine the sequence of intersecting ball-point pen lines. In a word, the discrediting factor was "pressure." The more pressure exerted by the writer onto the pen and, hence, by the ball of the pen onto the surface of the document as the line was drawn, the deeper the furrow in the paper surface. Additionally, the heavier the pressure, the more ink (within certain limits) was laid down. Correspondingly, the lighter the pressure on the pen point, the shallower the trough and the less ink. Although these facts have long been known to document examiners, they had extreme impact on the validity of this technique.

It was discovered that when lines were drawn with various degrees of pressure, incorrect interpretations of line sequence resulted. For example, when the first line was drawn with more pressure than the second intersecting line, the resultant lift gave the wrong interpretation of line sequence, that is, the first line appeared to be drawn last. This illusion resulted when the shallow trough of the second line did not reach the bottom of the first line's deeper furrow at their intersection; in effect, the lighter line skipped over the deep furrow and therefore failed to lay down an ink layer. When the tape was applied to the intersection and lifted, only the ink outline from the initial heavy stroke adhered to the tape. No ink outline was picked up at the intersection from the second lighter stroke, and the lift indicated the wrong sequence.

When the pressure sequence was reversed, that is, when the second line was drawn heavier than the first line, the lift of their intersection yielded a correct interpretation of the line sequence. The correctness of this determination, however, was due to the variation of pressure between the two lines rather than the validity of the lifting technique. In both instances of pressure variation (the first line with heavy pressure, then the second line with heavy pressure), the results were the same—the heavier line appeared to cut the lighter line in the tape lift. An example of this variable line pressure is graphically portrayed in Fig. 5.

That an incorrect interpretation of line intersection sequence can, in fact, result from this situation of variable pressure is shown in the photograph of the lift of four intersecting lines shown in Fig. 6*a*. In this photograph, no sequence of strokes will be interpreted correctly (the true sequence is shown in Fig. 6*b*) when compared with earlier photographs of valid sequences. The fact that pressure is the key to interpretation with this method can be seen in the various widths of the lines in Fig. 6*b*.

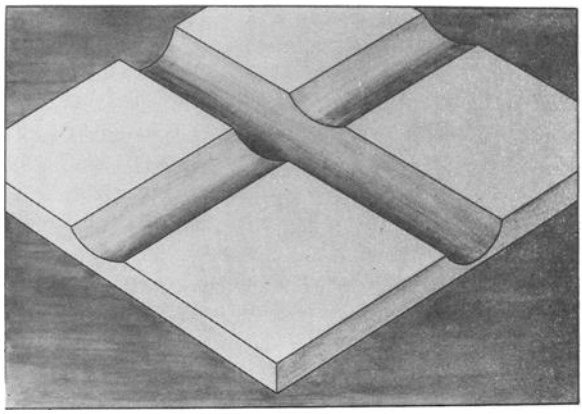

FIG. 5—*Drawing of intersecting lines portraying the variation in pressure between the lines. The deeper line appears to cut the shallower line.*

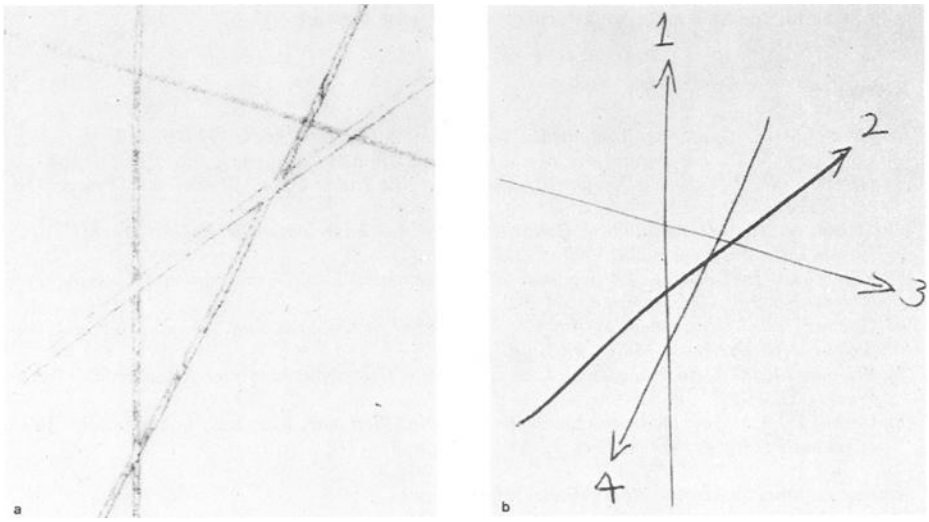

FIG. 6—(a) *Lift of four intersecting ball-point pen lines.* (b) *Actual lines from which the lift shown in* (a) *was made. It can be seen that no correct interpretation of sequence can be made. Note the variation in line widths for a suggestion of pressure differences.*

Summary

Since pressure variation determines the lift results, rather than the actual sequence of drawn lines, this proposed method has been discredited. The reader should be just about ready to ask the questions: "What did all of this prove and why present an invalid method that results in incorrect interpretations 50% of the time?" The following comments should justify both the reader's time and the author's efforts.

Although other document examiners may have actually attempted this method at some earlier time and reached the same conclusions as to its lack of credibility, a review of the

literature has failed to disclose any reference to this possibility. The fact that this particular technique has been tried—and has failed—has now been documented.

Secondly, Dr. Crown's comment that the Japanese technique appeared to have utility in other sequence of stroke problems encountered in this country was taken quite literally as a suggestion to "try it out, it might work." It was attempted and it did not work (at least this attempt did not); however, other modifications of the Japanese technique may still be of some use or application in other aspects of the problem.

Lastly, it is sincerely hoped that this information—although negative in nature—may serve to help insure that a grievous mistake will not be made by someone who might unwittingly employ this method in an attempt to determine line sequence. To be acceptable, expert testimony in a documents case must be demonstrative in nature, that is, it must include both reasons and illustrations of the expert's conclusions. Envision, if you will, a handwriting expert testifying as to the sequence of crossed lines on a questioned document. Envision this expert supporting his testimony with photographs of lifts similar to those depicted in Figs. 1, 3, and 4. This expert could actually present a demonstration in front of the judge and jury that would certainly prove his contentions to their satisfaction. Would the expert honestly believe he was correct in his interpretation of the lift? He might if his research had been only half-hearted. But, more importantly, the judge and jury might believe this type of demonstrative evidence, coupled with the expert's assurances. It is hoped that possible erroneous verdicts will now be avoided.

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