

# Determination of Sequence of Strokes-Conventional & Non-Conventional Techniques - A Review Study

R. Chandra\*, Sharwan Kumar

Central Forensic Science Laboratory, DFSS, MHA, Govt. of India, Chandigarh, India

## ABSTRACT

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The most important tool for a document examiner is his or her own vision, but in this section and the laboratory tour section we will consider the external tools which enable the examiner to see, evaluates and record more than is apparent to the unaided eye. The number of papers outlines the basic necessity of photographic illustrations for demonstrating the data offer clinching evidence, strong enough to with stand legal scrutiny on which opinions of the document examiner are based, hence play a very vital role in the examination of forensic documents. For the purpose of examination in the laboratory as well as the use of photographs becomes indispensable in cases involving traced or simulated forgery, built-up documents, forgery over genuine signatures and forgery by substitution, interpolations, differences in the tint of ink etc. The authors have solved a case in resolving the sequence of strokes with same ball point ink in an actual case received in the laboratory.

Keywords: Clinching Evidence, Strokes-Conventional, Forensic, Document, Strokes, Sequence, Ink

## I. INTRODUCTION

The sequencing of two lines which cross, or determination of which line was made first, is of considerable in certain cases. The concept of a layer of ink over another is easy to imagine but is not found in practice. Instead of forming a film, like a paint layer, ink is absorbed into the paper including several methods.

Pen and ink is an extremely limited medium, allowing only individual monochromatic strokes of the pen. Part of appeal and utility of pen and ink illustrations is that they can be easily printed

alongside text, using the same ink on the same paper without any degradation. The most commonly used textures include: hatching, formed by roughly parallel lines; cross-hatching, formed by overlapped hatching in several directions; and stippling, formed by small dots or very short lines. Textures can also be wavy, scribbled, or geometric and can appear hard or soft, mechanical or organic.

## II. METHODS

Liquid ink sequencing

Inks based on aqueous or other mobile solvents soak into the surface of normal paper entirely, and so

nothing can be determined from the apparent presence of a top layer. The situation is nearer that of a twice dyed piece of cloth; the darker color will dominate to the exclusion of the lighter. Evidence of the order of the crossing strokes is provided by the effect of one line on another. In the now largely obsolete iron-based inks the paper in the ink line was affected so that it would take up the ink of the second line and draw some of it away from the crossing by capillary action. This gave a darker appearance to the line along a distance of around on millimeter either side of the crossing, indicating that the partly darkened line was made first.

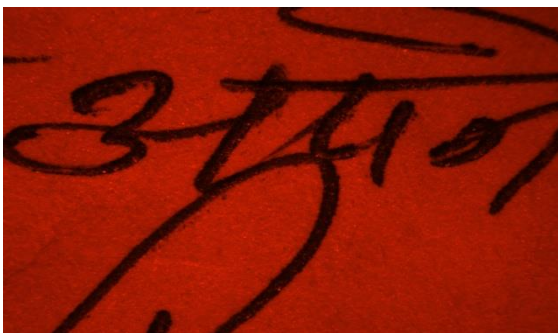


Fig. 1

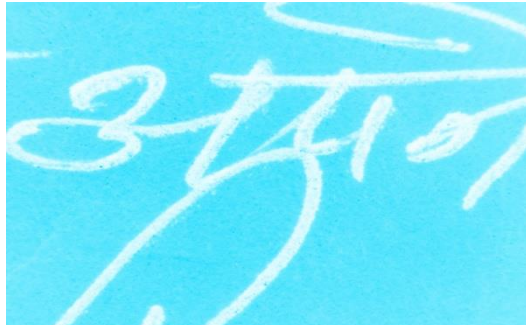


Fig. 2



Fig. 3



Fig. 4

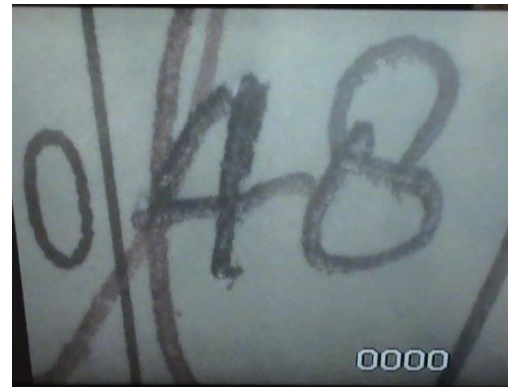


Fig. 5



Fig. 6

Fig. 1-6. Figures showing crossing of strokes between ball point pens of different inks under VSC-8000.

### Ball- point inks

Writing with ball- point pens requires heavier pressure than that needed for liquid ink pens. The impressions or grooves which are formed by this pressure can be exploited when considering which of two crossing lines was made first. A pen crossing a groove will be influenced to some extent by it, and this may be detectable. However, heavy pressure of the pen will distort the groove as it crosses it, and, if sufficient, will flatten the paper so that there is no

difference in the level of the surface at the crossing. Other methods have been described which use a high- powered microscope which combines a light source focused downwards on to the crossing point. These methods rely on a difference in the reflected light from the surface a continuous line indicating the upper stroke and the different broken reflection the lower one.

Ball- point and liquid ink lines written on glossy paper present few problems of sequencing. Because they are not absorbed into the paper but dry on the surface, they are affected by subsequent lines which cross them. There is a tendency for the ink to concentrate at the edges of the line, rather like squash lines in letterpress printing: the last- made line is indicated by unbroken parallel edges the crossing contrasting with the first- made edges which are broken.

### Sequencing of typewriting

The determination of the order of two typewritten entries made with liquid from fabric ribbons is, like those with similar inks from pens, unlikely to be possible. Again, the colouring material is taken up by the paper and does not rest on the surface. Similarly, type writings made by these ribbons which cross pen lines provide little or no evidence of their order of stroke. Determination of stroke sequence when carbon ribbons, which operate by depositing a piece of plastic film in the shape of a letter, are used is more successful. Deposits from carbon ribbons are examined by scanning electron microscopy. If they cross lines made with ball- point inks the sequence can be determined by observation of the relative position of each material. Their surface is also affected by pressure from the point of pen, and evidence of this can be found by careful observation of the enlargements.

Scanning electron microscopy of crossed lines may require the crossing to be removed and places in a small chamber in the instrument. It is therefore partly

a destructive method, and if the document must not be damaged it cannot be used. Although the piece of paper removed is not destroyed and could be examined later by another expert, the document cannot be restored to its previous condition.

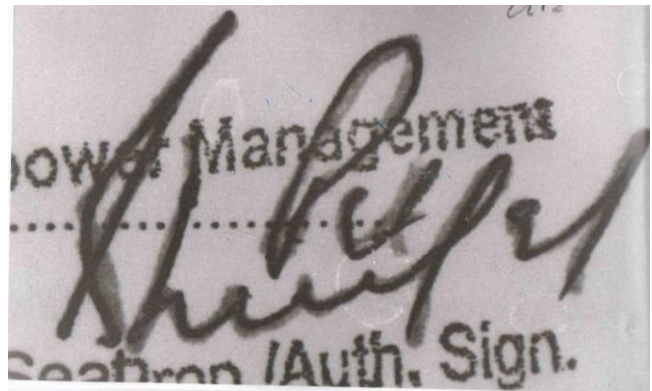


Fig. 7 Crossing of typewritten lines and ball point ink examined under VSC-8000.

### □ Striations

Another method depends on striations being present in the line made by a ball point pen. These are thin lines found within the line made by a pen and are caused by damage or dirt on the ball housing which prevents an even flow of ink. When such striations appear to run off the outside of the curve of a line the line made in the direction in which the striation seems to be travelling. None of these methods will be certain to give a clear indication of line direction, but they will not give the wrong answer if properly applied. Several examples of each letter and employment of a combination of the methods described on the pen movement can be established.

### Discussion

- These basic pen strokes are parts of original pen strokes and describe parts of pen movements that were executed during writing. After the extraction of basic pen strokes, the following step is to sequence the basic pen strokes in a way that replicates the most probable writing order to obtain a full pen trajectory

□ “ Both basic pen stroke extraction and stroke sequencing present large challenges for current trajectory recovery systems and do not work well enough to build reliable offline handwriting recognitions systems. In his Bachelor thesis, Gerke P bhathesis also explore new methods for extracting basic pen strokes from offline data and to sequence pen strokes in such a way that they resemble the correct writing order.”

An example of a multi-point collision of a two dimensional circle touching two lines at once as indicated by the gray crosses. In three dimensions a sphere could touch three planes at once; in special cases even more. These kinds of collisions do require more complex calculations.

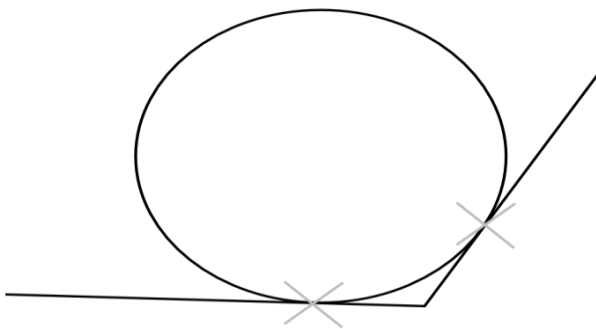


Fig. 8 Location of ball at the tip of ball pen.

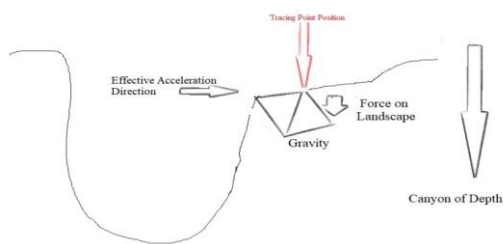


Fig. 9 Cross section of a handwriting canyon with a tracing point in it. The shown parallelogram of forces illustrates how the tracing point is pushed back into the canyon by and the slant of the canyon.

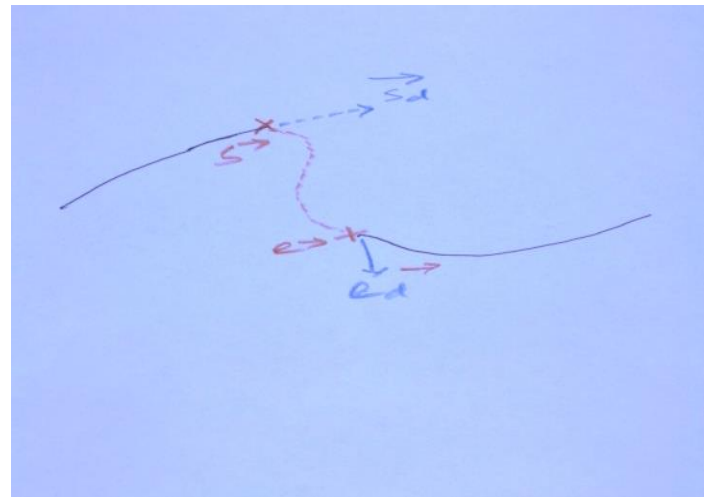


Fig. 10 Values that need to be fit by the third-order polynomial in order to describe the pen-up transition from one pen stroke to the next.

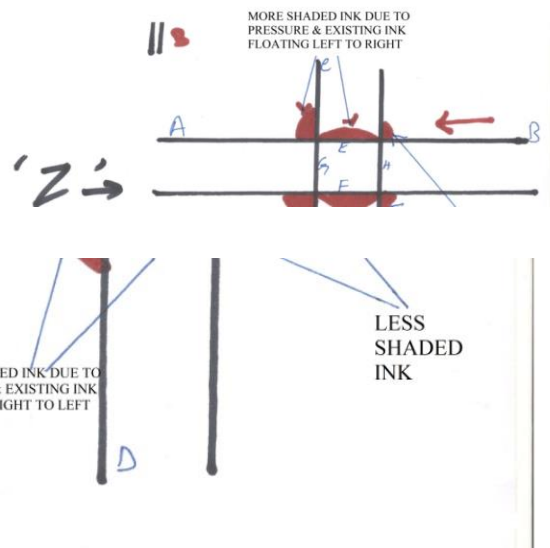
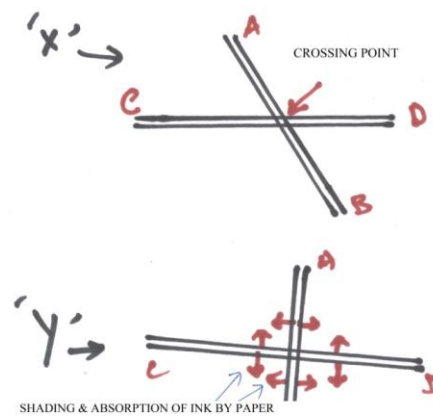


Fig. 11. It indicates the line marked AB is over the line marked CD in 'Z'. There is no shading in the side of GH and location of shading in EF indicates that CD

line is located below.

**Fluid inks and instruments**

- i) Water based
- ii) Glycol based Rolling markers, felt or fiber, tipped pens, extruded plastic nibs, fountain pens.
- iii) Solvent based- Permanent markers (fine or board tip pens).

Paper consists primarily of cellulose fibers from plant materials. The most common sources of paper fibers today are cotton, wood and mixtures of cotton and wood in various proportions. Other less frequently used fibers originate from rag, jute, straw, abaca, bamboo, bagasse, esparto and flax hurds

Blue	Water	96.33 % (+/- 5%)
	Ethylene glycol	3.97%
	Methylene blue	0.81%
	Glucose	0.41%
	Phenol	0.31%
Red	Water	96.33%
	Glycerine	3.97%
	Acid dye bright-red	0.53%
	Glucose	0.41%
	Phenol	0.31%
	Acid dye red #2	0.28%

**III. CONCLUSION**

Nondestructive analysis of two ink strokes in order to determine their sequence still poses a difficult problem for Forensic Document Examiners. A number of attempts have been made in the past using Comparison microscopy and Docu-centre expert to address the problem. In some cases destructive analysis is also suggested, but since the evidentiary value of the exhibit under examination shall cease to exist, such a technique is not advised in actual casework. In this work, the sequence of two intersecting strokes has been determined by studying the reflectance spectra of ink strokes at different points, viz. one each on two intersecting strokes and the third at the point of their intersection using a video spectral comparator 2000HR (VSC-2000HR). The striations and shading were playing the very important role in this case. The authors have experimented with determining the sequence of two same ink strokes.

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