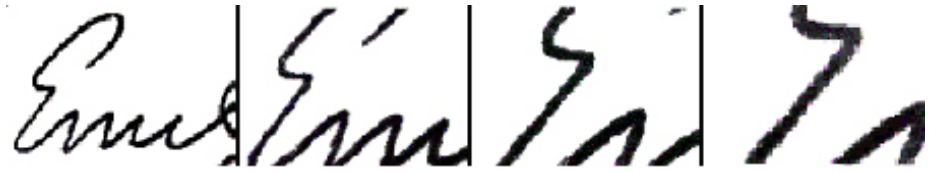
The Microscope:
Through the Looking Glass

Opinions reached in the forensic examination of documents and handwriting often hinge on characteristics that are small in size, but large in significance. The examiner must be able to see, evaluate and demonstrate the evidence. Evaluation of evidence calls upon the knowledge, experience, and judgment of the examiner, but to see the evidence and record it, the examiner needs tools. The most important tool a document examiner has, aside from his or her own vision and thought process, is the microscope, which helps the examiner to see and record more than is apparent to the unaided eye. Technology brings document examiners new devices that supplement or work with the microscope to accomplish these tasks. But the microscope itself is still essential in document examination.

It might seem that the more powerful the microscope in terms of magnification, the better, but for handwriting or typewriting examination, this is not the case. Most handwriting examination is done at powers of 5x to 50x. When magnification is higher, the field of vision is so narrow that the material viewed loses relevance. In Figure 1 below, a signature is shown at 10x,15x, 20x and 25x.



10x 15x 20x 25x

Figure 1 The same signature photographed at increasing magnifications.

What type of microscope is best for document examination? The subject of examination is most often handwritten or machine printed ink on paper. But sooner or later, most document examiners have reason to examine staple holes, perforations, folds, abrasions of the surface and other artifacts found on the surface of paper, plastic, metal, wood and other materials. These examinations of relatively opaque materials call for reflective, rather than refractive microscopes. Light from above that can be directed from different angles and moderated to various intensities allows the document examiner to work with all three dimensions of a document.

Yes, three dimensions. Ink on paper might seem like a two dimensional construct that would not require the use of a stereomicroscope. But that is not the case. Consider just one aspect of document examination – the identification of handwriting. As one writes, he or she pushes and pulls the writng instrument across the paper while pressing down into the paper. The pressure into the paper is not constant, but rather varies according to how the pen is grasped, the posture of the writer, the strength of the writer, the speed of the writing, and other factors. Identifiable patterns of pressure may occur. Thus, the third dimension of depth, caused by pressure on the writing instrument is significant. The best microscope for document examination is a relatively low power microscope that is both reflective and stereoscopic.

Another plus of the stereomicroscope is the natural, comfortable feel of the instrument that results from being able to use both eyes for viewing. The

document examiner is often looking through the scope for long periods of time while considering the various details revealed. Comfort becomes important.

Someone attempting to emulate the writing of another person may do a creditable job of recreating the overall "look" of a signature – perhaps a good enough job to convince a hurried store clerk. But because handwriting is a product of each person's mental process and physiology, it can not be copied exactly in all its details. One person can not get inside the mind and body of another.

The significant details that reveal the presence of a same or different writer may only be visible through the microscope. For example, in the images below, the presence of two writers was detected in part because one writer consistently formed the letter "o" in a clockwise direction (Figure 2a), while the other consistently formed the same letter in a counter-clockwise direction (Figure 2b). Using the stereomicroscope the examiner could see the striations that move from the inside to the outside of a curve in the direction of travel of a ball-point pen (much the same way that a sports car is thrown to the outside of a sharp curve).

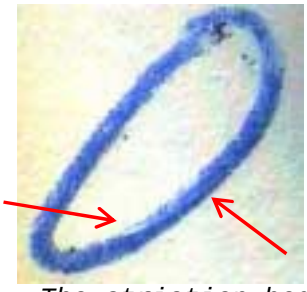
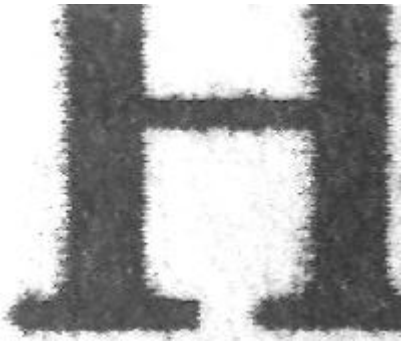


Figure 2a The striation begins at the 5 o'clock position on the inside of the letter and moves to the outside of the letter at the 3 o'clock position. Therefore, the letter is formed in the counter-clockwise direction

Figure 2b The striation is more difficult to see in this letter, but it begins at the 7 o'clock position on the inside of the curve and moves to the 9 o'clock position at the outside of the curve. The letter is formed in the clockwise direction.

Machine printed documents are often the subject of document examination. Perhaps the examiner needs to determine the type of machine that produced the document. Figure 3 shows part of a printed "H" which has "overspray" on the left side of each vertical segment of the character. This is one indicator that the source might be an ink jet printer and that the print head was traveling from right to left when this character was placed on the paper.

Figure 3 - *The flow of ink starts more precisely than it ends. The overspray, which is more ragged to the left of each vertical, therefore indicates print head movement from right to left.*



Perhaps the reader wonders about the source of the illustrations presented. The most useful of all stereomicroscopes has a third “tube” to allow for the attachment of a camera. Typically, a shunt transfers the image from one of the two ocular tubes to the third, or photo, tube so that the image captured is not a true stereo image. In the past, the camera would probably have been a 35mm still camera or a video camera. Today, it could easily be a digital camera. Both analog and digital cameras have been used to produce the figures presented here.

Two typical setups are shown in Figure 4 below. On the left is a 35mm camera coupled to the microscope. The series of images presented in Figure 1 of this article were captured in this manner.

On the right is a Ken-A-Vision 7600 Flex Camera which actually captures a digital video image through the eyepiece of any microscope, obviating the need for the trinocular scope. The camera links the microscope directly to a computer. A real time video image is visible on the computer screen, and when the examiner has what he or she wants to capture, the software takes a still image. Figures 2, 3 and 5 were all taken with the setup described here. The images in Figure 4 are digital still images.

Figure 4 - *Two setups for capturing what the microscope reveals.*

The digital still camera and cameras such as the Ken-A-Vision Video Flex are able to focus to within 6 cm of a document. It might seem that they would even replace the microscope. However, for many reasons, while they are terrific supplements to the microscope, they do not replace it. As mentioned earlier, only the stereomicroscope gives the examiner a full three dimensional look at the subject. There are also special purpose microscopes that give the document examiner additional viewing tools.

A type of microscope that is particularly useful in document examination is the comparison microscope. Two documents can be viewed one above the other, and the images can be optically positioned so that they appear to overlay each other. By using a different color of filter on each document, the examiner can then see a third color in those areas where the two segments being compared overlap each other. Figure 5

(left) shows the results when two signatures are viewed under the comparison microscope at 15x. The interplay of colored light makes this image a bit confusing to the first time viewer, but essentially you are seeing a composite of two signatures (one viewed through a red filter and one viewed through a green filter) in which the black line segments are the places where the two signatures would coincide if the signatures were really on top of each other.

The microscope is valuable to the document examiner in two ways. First, the microscope reveals details that are critical to the forensic examination of documents. Second, the microscope is part of a system for recording and presenting evidence to the parties involved in a document dispute. The examiner is able to state and explain his or her opinion, but the best service is given when the examiner goes the final step of illustrating testimony by allowing all parties to see and understand what the examiner sees through the microscope.

Biographic Information:

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