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## CRIME AND PUNISHMENT VOLUME 3 QUESTIONED DOCUMENTS INK DATING

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The field of questioned documents examination covers several issues. The best known is the examination of handwriting, hand printing, and signatures for authorship. Other activities are impression analysis, infrared testing, microscopy, typewriter analysis, photocopy analysis, and the restoration of bumed or faded documents. The newest focus, the dating of inks and documents through chemical examinations, began in the late 1960's and continues to expand. These examinations can assist in photocopy dating, printed documents dating, and even facsimile dating. This entry explains the techniques of document examination and provides examples of how they are used in litigation and investigations.

### EXAMINATION OF SIGNATURES

The examination of signatures can answer several questions. The first is whether a questioned signature was signed by its purported author. This question is commonly asked when a will, a mortgage, or a contract is disputed. In order to conduct a proper examination of a signature, the document examiner first needs the original document that contains the questioned signature. If the original is not available, a qualified opinion can often be given after examination of a photocopy, photograph, microfiche, or facsimile copy. The problem with not having the original is that several methods of forgery may not be detectable by examining something other than the original. The second item needed to determine authorship is known signatures from the purported author. Usually eight to twelve signatures are needed as a guideline; however, valid examinations can be done using less than eight; or they may require more than twelve. The closer in time the dates of the known signatures are to the date of the questioned signature, the more meaningful the examination will be.

### TYPES OF FORGERY

There are four main types of forgery. The first is *blind forgery*, in which the forger has no idea what the signature to be forged looks like. This is the easiest type of forgery to detect because it is usually not close to the appearance of a genuine signature. This type of forgery will sometimes allow an examiner to identify who made the forgery based on the handwriting habits that are present in the forged signature. In order to perform this type of examination, an examiner needs known cursive writing samples of the suspected forger in order to compare the handwriting habits in the questioned signature to the habits in the known cursive writing.

The second (and probably most common) type of forgery is *simulation*, in which the forger has a sample of the signature to be forged. The quality of a simulation depends on how much the forger

practices before attempting the actual forgery, the ability of the forger, and the forger's attention to detail in simulating the signature. This type of forgery is usually easily detectable by a trained document examiner when examining the original document or even a copy. Because the forger is trying to simulate the handwriting habits of someone else, the forger's own handwriting habits are masked. Therefore, it is often difficult to identify who forged a simulation.

The third type of forgery is a *tracing*. A tracing can be done by holding the model document and the questioned document up to light and using a pen to trace the lines of the model signature onto the questioned document. A tracing can also be done by using a blunt stylus on the questioned document to create an impression of the model signature in the paper. This impression is then filled in with a pen to create the appearance of the model signature. If the model signature used by the forger is not found, this type of forgery is sometimes difficult to detect from a photocopy.

The fourth type of forgery is an *optical transfer*, in which a genuine signature is transferred onto a document by use of a photocopier, scanner, facsimile machine, or photography. With this type of forgery, an examiner cannot positively identify a signature as genuine without having the Original for comparison. Indications of this type of forgery are often but not always present on a copy of the questioned document. Extreme care should be taken by anyone, especially the court system, in evaluating the veracity of documents and signatures when no original can be produced.

#### IMPRESSION ANALYSIS, INFRARED TESTING, AND MICROSCOPY

Another major activity of questioned document examination relies on impression analysis, infrared testing, and microscopy to detect alterations, additions, and rewritings in documents. This form of examination is most useful for documents such as medical records, diaries, and logbooks. Impression analysis is used to detect impressed writings on paper. This analysis can determine which documents were under a document when it was written on. This determination can be significant in several situations. The most obvious situation is one in which the writing on one document is impressed onto another document. This can be useful in examinations in several circumstances, such as when the writing is dated before the document containing the impressed writings was created. This circumstance is common when documents are in a medical me, for example, a medical chart atop a medical laboratory report. If someone writes an addition on the chart, and the addition bears a date that is earlier than the date when the laboratory report was created, and the impressions from the writing are into the report, one can say with certainty that the writing that created the impressions was made after the report was created and placed in the file so that it could receive the impressions. Impression analysis can also aid in examinations for additions and alterations when only a portion of an entry is questioned. If the impressions for the unquestioned portion of the entry are found impressed in a different document or in a different spatial relationship. An examiner can conclude that the two portions of the entry were written at different times, although an exact measure of this difference cannot be made without knowing the date of the document that received the impressions. Other determinations that can be made by impression analysis are practice attempts of a document, the sequence in which a series of documents was written (i.e., first to last or last to first), and the location of documents at the time of writing (i.e., an anesthesia record from surgery should not be written on top of nurse's notes in the patient's chart).

Infrared testing can be used to detect differences in inks by the manner in which they reflect and absorb infrared light. Two inks that appear identical in room light may appear different under infrared light if they are chemically different.

Analysis by microscopy can detect differences in pens used even if the same ink formulation was used in each pen. This analysis is done by examining the writing to determine the damage to the

pen. This analysis can lead only to a conclusion that different pens were used. Similarities have significance; however, similarities cannot lead to a conclusion that the same pen was used. This type of analysis is done when a portion of an entry is questioned and should have been written with the same pen that made the unquestioned portion of that entry. If the inking patterns of the two portions of the entry are different, one can conclude that they were not written with the same pen at the same time.

## CHEMICAL TESTING OF INK

Chemical testing of ink has several forms and can be used in many situations. Most forms use thin-layer chromatography (TLC) as either the manner in which samples are compared or the medium upon which samples are measured. The simplest form of TLC is used to determine if two inks are of the same formulation. This test separates the dyes of the inks on the TLC plate. Comparisons can then be made of the color of each dye, the distance each dye traveled from the origin, the shape of each dye, and the relative intensity of each dye from one sample to another. After the dyes of two or more inks are separated, quantitative analysis can be done to compare the relative intensities of each dye component to one another, to detect the presence or absence of different batches of the same formulation. Differences in batches would indicate that the same formulation of ink was used but that different writing instruments were used. The intensities are calculated by using a scanning video densitometer to find the absorbance of each dye band. The values are then normalized by dividing the value for each dye by another. For example, in an ink with three dyes the ratios would be dye 1/dye 2, dye 2/dye 3, and dye 1/dye 3. If any significant differences are found between two samples, the samples are concluded to be from different batches. In most cases, it is desirable to run the samples in duplicate or triplicate.

## CHEMICAL DATING OF INKS

The chemical dating of inks is done in three primary forms. The first form compares an ink to a known dated library of inks to determine the manufacturer and type of ink and when the ink was first commercially available. The second form determines whether the ink contains a chemical date tag, which indicates the year when the ink was produced. Chemical date tags have not been used in inks since June 1994, and only about one-third of the ballpoint inks in North America contained a chemical date tag. The first two forms of chemical dating indicate only when an ink was first manufactured. The third form determines how long an ink has been on a document. This form of dating is called relative ink age determination.

Three primary methods are used to determine the relative age between ink samples. The first method is the rate of extraction (R-ratios), which measures the rate at which an ink will extract in a weak solvent. The second method is the extent of extraction (percent extraction), which measures the amount of ink extracted in a weak solvent compared to the total amount of ink in the sample being analyzed. The third method is the dye ratio method, which detects changes in the ratios between the dyes in an ink as it ages. As the term *relative ink age determination* implies, testing compares two or more samples to determine the relative age of a questioned entry.

Known dated entries are the most desirable for comparison purposes. The comparison sample must be the same type of ink on the same type of paper (unless it can be shown that the paper does not have a significant effect on the testing results). Ideally, the submitted documents contain an ink that can be used as a comparison to the questioned entry. This is often the case in medical records, where there are many entries, some usually of unquestioned date and some of questioned date. A comparison of the relative ages of samples can be made between an entry of known date and a questioned entry after it can be shown that the two inks are of the same formulation. Differences in

age of six months or less typically cannot be detected by relative ink age tests. After approximately three and one-half years, the changes in ink over time that can be analyzed cannot be detected.

In some instances when a document contains a lone ink and no other ink that is of unquestioned date is available for comparison with the questioned ink, comparison samples can be generated. Depending on the purported date of the writing of the questioned entry, two types of ink comparison samples can be generated. The first type of sample is available if the formulation and manufacturer of the ink can be identified. A new sample of that ink is placed on the questioned document to approximate a sample of ink that was recently written. The second type of sample is artificially aged to approximate a sample of ink that is completely dry. The artificially aged sample is created by heating the ink in a vial at 100° C for thirty minutes to produce the equivalent of a sample of ink that is three and one-half years old or more. This method is called accelerated aging. Either of these samples can then be compared to a questioned sample of ink by using the three relative ink age comparison tests discussed earlier. These tests can then determine when a questioned sample of ink was written, based on the aforementioned limitations of natural age and discriminating power