9 Understanding the Nature of Document Evidence

Nikolaos Kalantzis*
Chartoularios Laboratory of Questioned Document Studies, Piraeus, Greece and Department of Forensic and Crime Science, Staffordshire University, Stoke-on-Trent, Staffordshire, UK

9.1 Introduction 134
9.2 Handwriting Evidence 135
9.2.1 Handwriting as evidence 135
9.2.2 Feature examination 135
9.2.3 Forgery 136
9.2.4 Further comments 137
9.3 Document Evidence 138
9.3.1 Ink/writing instruments (sequence) 138
9.3.2 Printed media 139
9.3.3 Paper 140
9.4 Additional Issues Regarding the Evidential Value of Documents 141
9.4.1 Photocopies as evidence 141
9.4.2 Age and dating of documents 143
9.4.3 Stipulation of conclusions 143

9.1 Introduction

The title of this chapter is very descriptive of both the positive and negative aspects of documents when treated as evidence. The term 'document' in a forensic aspect includes all aspects of a document, i.e. handwriting, signature, printing, the ink and the paper itself. As such we all have personal experience of some or all of these aspects. That personal experience, varying from one person to another, can provide useful insight, but can also limit one's view or perception of the evidence.

The basic question posed to document examination is the authenticity of handwriting; therefore, the comparison always takes place between the questioned writing (i.e. the writing of unknown or contested origin) and the specimen material (i.e. writing of known and confirmed origin). The same stands for documents (e.g. passports, banknotes, etc.).

In this chapter the principles of the holistic examination of documents is presented, giving an initial comprehension of the forensic approach.

*Corresponding author: nkalantzis@chartoularios.gr

9.2 Handwriting Evidence

The most common but also most important piece of evidence located on a document is handwriting, in any form. The process of handwriting and signing is essentially the same, and therefore are treated as different aspects of the same behaviour throughout this chapter following the same rules and principles of analysis and examination.

9.2.1 Handwriting as evidence

The essential features of handwriting that allow it to be treated as forensically valuable evidence are uniqueness and repeatability. When these two criteria are not met, forensic handwriting examination cannot take place within scientific boundaries. The problem of proof for the uniqueness of handwriting and signatures appeared intensely during the 1990s as an application of the Daubert Rulings (Berger, 2005) on handwriting evidence (Zlotnick and Lin, 2001), forcing the forensic community to research and prove the scientific validity of their methodology.

On a theoretical level, the function of the neurons in the brain and their synapses provide a very complex network through which hand movement produces handwriting (Hecker, 1993; Caligiuri and Mohammed, 2012). Not only that, but through years of practice the process of writing moves from the conscious competence to the unconscious competence, and the muscles are trained and grown to accommodate pen movement. This leads to the formation of a unique combination of individual characteristics, allowing them to be studied, examined and compared by the trained examiner.

On a practical level, a series of blind tests and proficiency trials carried out mainly from La Trobe University (Found *et al.*, 1999; Sita *et al.*, 2002) proved both the validity of handwritten evidence (meeting the two aforementioned criteria) and the ability of trained document examiners to determine authenticity through specific methodological examination, meeting the Daubert standard.

9.2.2 Feature examination

The methodology followed by the trained document examiner, using first the naked eye and then appropriate magnifying equipment (loupe, stereomicroscope, etc.), requires the analysis and then the comparison of specific features. Comparison always takes place among similar writing features, i.e. capital letters of the questioned writing are compared with capital letters of the specimen material. The main styles of handwriting are block capitals, disconnected lower case, connected lower case and mixed writing forms.

The general characteristics that are most commonly identified, analysed and compared include the following.

- Style and legibility, describing the general appearance of the writing.
- Size and proportions, referring both to the individual letter within a word and to segments of the letter.
- Spacing of words within a sentence and of letters within a word.
- Slant and slope.
- Fluency and pressure of handwriting, which is also evidence of the skilfulness of the writer.
- Additional features might be also discussed, depending on each case (e.g. punctuation, layout, etc.).

Detailed examination then takes place of the more individual characteristics of handwriting, including the following.

- The individual character shape, referring both to the execution parameters (smoothness of curves) and to the structural form.
- Individual character proportions and construction, analysing the direction and speed traced by the writing instrument, the number of strokes used.
- Character combination and connections, both in usual joins (e.g. ‘th’) and in unique combinations that can possibly be found in the analysed writing.

The next step of the analysis requires the comparison of the analysed features between the questioned writing and the specimen material.

An important factor to be considered during the comparison phase of the examination is natural variation. Writing is a dynamic aspect of human behaviour, and as such it undergoes continuous but not always discerning differentiation, due to numerous influences and various degrees of natural change. A person can produce writings that present subtle differences of no importance as a whole, that shape a concrete pattern. This set of resembling writings in their total is unique for each person and cannot be simulated or copied.

Equally to be considered is the quality (referring to the type of writing in relation to the questioned material, and the timeframe in relation to the assumed date of writing of the questioned document) and quantity (to establish the range of natural variation) of the specimen material. As time progresses, writing also progresses and changes. This aspect of handwriting needs to be taken into account, and be well documented in the specimen material, otherwise gaps of information appear and specific forms of variation might be erroneously misinterpreted as dissimilarities rather than variations of authentic writing. For example, if the authenticity of a last will and testament that was assumed to be written in 2007 is examined, and the specimen material dates from 1974 to 1984, that material is limited, not necessarily exhibiting the full range of the handwriting features of the testator (author of the will) at the assumed time of writing. Comparison with only that material might lead to erroneous conclusions. For such a case, in order to come to a safe conclusion, additional specimen documents may be required, dating as close to the year of the testament writing as possible.

Finally, other special factors can be introduced in the analysis, depending on the specific case details and the assumed author's background history. Outside factors like drug or medication use, alcohol consumption, mental illness or even injury (e.g. a broken arm that is recovering), may affect the writing procedure. In addition, environmental conditions might come into play (e.g. completing a form while standing up, in haste or under duress) and may need to be taken into account.

From a forensic point of view, the comparison of characteristics is not a simple addition and subtraction of similarities and dissimilarities. Even if only one unexplained dissimilarity persists (and cannot be interpreted as accidental), then, regardless of number of similarities, the examined writing should not be considered authentic.

9.2.3 Forgery

When unexplainable dissimilarities persist in the questioned material, a conclusion of forgery is very likely to be formed. Forgery can take place in several forms, including the following.

- Simulation, when the forger attempts to imitate the victim's natural handwriting or signature.
- Freehand forgery, when the forger either is unfamiliar with the victim's specimen or puts no effort into copying it.
- Tracing, when the forger uses an authentic writing or signature as a guide, tracing it to the forged document.
- Transfer, when the forger scans and prints an authentic handwriting or signature through mechanical means.
- Disguise, when the writer attempts to mask his characteristics in order to deny authorship.

When simulation occurs, the forger has access to documents containing the authentic material of the victim, and faces the following challenge: he has to replicate the process of years of training (of both the brain and the muscles of the arm) of his victim, in order to produce (for example) a signature with accuracy of form (drawing the exact same features) and dynamics (exhibiting the same speed and pressure characteristics). This task is unfeasible, and the forger usually balances between two extremes, either successful execution of the structure of the signature by slowly building it (producing slow and carefully plotted lines, with heavy unnatural pressure in order to control the movement of the writing instrument), or

pre-forms a speedy and fluent formation that lacks the unnatural characteristics of the slow execution, but also lacks the accuracy of the signature formation (as the forger is not trained in natural execution of the victim's signature).

In freehand forgery, the forger will execute a fast and fluent formation (as there is no effort to 'copy' an original form). The resulting forgery will probably have no resemblance to the specimen material (and may even contain spelling mistakes). Most importantly, as freehand forgeries are quickly executed, they may include parts of the authentic signatures of the forger, that survive and are included in the fraudulent formation by accident (as it is part of the unconscious competence). For example, a forger signing a cheque as 'Mr Philip Morton', in an effort to add natural characteristics and fluency to the freehand forgery, adds a double underline in the same manner as he does with his own true signature.

This does not always happen, but when it does, it gives the document examiner the opportunity to investigate the authorship of the forgery (provided that the surviving unconsciously executed part contains enough information to provide a link to the forger's authentic signatures).

When the forger has access to original material, and has the luxury of time, tracing can be attempted, using that material as a guide. Several approaches of tracing can be followed, all of which leave evidence on the resulting forgery. Main characteristics of tracing include unnatural execution of curves, inclusion of pen stops and pen lifts, unnatural pressure and slow speed of execution. Also, depending on the method used, signs of the trace can be found on the document (e.g. a pencil or indentation used to form the trace of the signature).

Similar to tracing conditions, a forger with basic skills in computers and access to specimen material may use everyday computer equipment to scan, manipulate and print 'authentic' writing and signatures on fraudulent documents. These forgeries are very dangerous, as, without proper caution on the examiner's part, they can be misinterpreted as genuine. If examined in their original form, the microscopic examination will straightforwardly reveal the writing to be a product of printing (or other method of reproduction) and not normal writing (via a writing instrument). If these forgeries are photocopied and then examined (without access to the 'original'), the document examiner will not be in a position to determine whether the writing represented in the document was originally written there or printed.

Disguise is the most difficult forgery type to be encountered. The author already knows his writing features and can easily attempt to hide them from the examiner. Depending on the penmanship of that person and the knowledge of the principles of handwriting examination, it is possible to produce a signature or handwriting that cannot be scientifically linked to the original writer. Again, as with the double underline feature in the freehand forgery example, there is the possibility that the resulting disguised handwriting product contains formation too complex and unique to belong to anyone other than the original writer, allowing the examiner to state that even though the disguised writing is not 'authentic' (i.e. it is not similar to *all* of its features to the specimen material), it is too similar to belong to anyone else and therefore is still linked to the author; but this is the exception rather than the rule.

9.2.4 Further comments

One common misconception regarding handwriting evidence is the assumed link between the writing product and the psychological state of the writer, the study of which is called graphology. It is undeniable that heavy emotional burden or duress (e.g. signing a contract at gunpoint) will affect some handwriting features (most likely causing tremor). However, these features cannot be tracked to one unique cause (for instance, exhaustion from quickly climbing four flights of stairs will also introduce tremor in handwriting) and therefore do not meet the aforementioned criteria or reproducibility. When forensic handwriting examination was first introduced, it was believed

that such a link existed, but academic and field research (especially in the post-Daubert era) found no supporting evidence for graphology (Jennings *et al.*, 1982; Furnham and Gunter, 1987).

Another aspect of handwriting that needs to be taken into account is class characteristics. Specific cultural or regional groups may contain in their handwriting features that are uncommon to persons outside these groups, e.g. people who use English as a second language and have a non-Latin alphabet in their mother tongue may exhibit uncommon characteristics. If such peculiarities are not familiar to and taken into account by the examiner, they may be inaccurately evaluated, leading to an erroneous conclusion. The most well-known example of such misinterpretation is the identification of German handwriting class characteristics as individual handwriting characteristics in the Lindbergh kidnapping case (Saferstein, 2007).

Graffiti is also a form of handwriting. The physics and the position of arm and body are different to those encountered in everyday handwriting, but the mental process is the same. Therefore, in principle, graffiti is also subject to the methodology of forensic handwriting examination. Studies have established repeatability and uniqueness in forms of graffiti-like 'tags' (a way of graffiti signing), allowing the examiners to form conclusions on authorship (Hussong, 2001; Sadorf, 2001).

Finally, serial skilful forgers with in-depth knowledge of the principles of handwriting examination can produce forgeries that can be difficult to detect. Such forgeries lack the spontaneity and the natural variation of the authentic signatures and, therefore, if more than one forgery exists they are bound to be too similar (i.e. without variation) allowing the examiner to properly identify them as forgeries.

9.3 Document Evidence

The document itself can provide a lot of useful information for a forensic examination, depending on the case and the mandate (i.e. the request for examination).

9.3.1 Ink/writing instruments (sequence)

Apart from the handwriting features pertaining to the writer, every writing instrument introduces its own category of characteristics to the examined writing. These features derive from both the ink that is deposited on the writing surface and the method of delivery of that ink to the paper surface. The examination of these features can provide helpful information (and proof) regarding alterations on a document, i.e. additions to the originally written document. For example, a cheque bearing the amount of €18,000 is contested, and the person issuing the cheque claims that the original amount was €3000.

The type of ink affects the image of the ink line, as more viscous inks (e.g. fountain pen) will soak the paper surface much more than paste-based inks (e.g. biro). The delivery mechanism also leaves a pattern on the paper surface, distinctive of its class (i.e. unique to fountain pens or ballpoint pens, etc.). With the cheque example, the forger might have used a different type of pen (i.e. a different class of writing instrument) to transform €3000 into €18,000. For example, the revolving ball of rollerball fluid ink pens will 'push' the ink to the sides, leaving a distinctive pattern on the written line, which is very different from the fibre tip pen, which only deposits the ink on the paper (with no revolving parts).

Apart from distinguishing the class of the writing instrument used, which on its own can provide helpful information, the colour properties of the ink used are also examined. Ink is a mixture of different chemical components, some of which provide the colour perceived by the human eye (i.e. in the 390–700 nm part of the electromagnetic spectrum), while others have to do with the kinetic and storing properties of the mixture. Different inks have different compositions and therefore can be distinguished chemically.

Chemical examinations for ink analysis involve chromatography: usually Thin Layer Chromatography (TLC), High Performance Liquid Chromatography (HPLC), Raman spectroscopy, or other chemical procedures destructive to the document (Brunelle and Crawford, 2003).

Apart from the destructive analytical approach, there are visual and spectroscopic methodologies that can provide ink differentiation. Every object reflects light in a specific set of wavelengths, depending both on the source wavelength(s) and the chemical properties of the object. As a result, the human eye perceives colours, i.e. a specific combination of wavelengths reflected by the object. Our eyes are limited to the visible spectrum as they cannot perceive anything above or below, but objects are not limited to it and can reflect in other areas of the electromagnetic spectrum. Therefore two inks that look identical in colour to the naked eye (i.e. reflect light in the same way in the visible spectrum) may behave differently in other parts of the electromagnetic spectrum, and specifically the infrared and ultraviolet areas of the spectrum.

To investigate this behaviour, special instruments are required with infrared sensitive cameras, and controlled light conditions. The instruments (usually called Video Spectral Comparators) control the source light and filter the reflected light appropriately into the recording camera, achieving infrared reflectance, infrared absorption or infrared luminescence of inks.

Other potentially useful information that can be deduced by ink analysis involves line crossings and sequence. For example, a printed document is presented, bearing a signature that overlaps with the last printed line of text, the owner of the signature claims that when he signed the document the last line was absent. In such a case, the sequence of the overlapping lines (i.e. the line of the signature and the line of the printing of the last sentence) will be examined. If the sequence can be determined, then the claim of the owner of the signature can be proved or disproved.

The deduction of sequence is very difficult and there is no uniform method that applies in all ink or printing combinations. The type of inks or printing involved in the crossing defines the possibility to determine the line sequence. Methodological approaches to this problem involve study under the stereomicroscope with perpendicular light, examination with an ElectroStatic Detection Apparatus (ESDA™), or even Scanning Electron Microscopy (SEM). Research is still being carried out to create a definitive methodology to determine sequence by analysing the depth of the strokes, and there is potential for 3D Raman Spectroscopy as the tool for this purpose.

9.3.2 Printed media

Following the same principles as for writing instruments, printed documents bear the class and individual characteristics of the ink or toner used and the method with which it was delivered to the paper surface. There are several different types of printing devices, depending on their mechanism. Typewriters and dot matrix printers once were commonplace in the work environment, but now the most common types encountered in the workplace and at home are inkjet printers and laser printers. The main difference between these two devices is the substance used to print (i.e. form the desired image or text on the paper surface). Inkjet printers use formulations of fluid ink, while laser printers use toner.

Furthermore, the delivery mechanism is different as inkjet printers mainly spray the ink on the paper surface, while laser printers transfer the toner particles through the use of charged drums within the rolling mechanism of the printer. What is important is the difference in features of the resulting printing each type of printer leaves on the document.

Inkjet printers spray the ink while reproducing the original image or text, resulting in printing of only medium detail, if examined under the microscope. On the other hand, laser printing allows for more accurate printing, with sharper detail.

Accurate identification and differentiation of these two printing methods can be detected using a microscope. Additionally, other characteristics that provide printer class identification include ink or toner spatter patterns. When the inkjet printing head delivers the desired ink quantity on the paper, additional small ink droplets will randomly fall, creating a spatter pattern around the

printed text. That pattern, even though it is not unique, is located around the printed areas of the document. Laser printers also exhibit a toner spatter pattern, but this is due to a different phenomenon, pertaining to the different printing mechanism. The drum of the laser printer is charged appropriately to guide the toner particles to the specific areas required on the paper surface to reproduce the image or text desired. Due to electrostatics, there will be random flaws in the charging of the drum that result in a random pattern of small toner particles. The main difference from the inkjet spatter pattern is that because the entire page passes through the charged drum, the entire page is exposed to the random flaws of the electrostatic field, and therefore the toner spatter will appear throughout the printed page.

Apart from class identification, unique printer identification may be achieved, provided that the printer used produces identification marks on the paper surface. Such marks can be caused unintentionally by wear of the paper-loading mechanism or by flaws in the printing system.

A device-specific feature that provides complete identification of the printer that is unique to certain laser printers is the yellow dots pattern (Li and Leung, 1998). Many colour laser printers have been manufactured to include a faint pattern of yellow dots in every print they produce. That pattern can be decoded through a program available to government agencies; this may provide the maker, the type, the model and the serial number of the printer used, and sometimes it will include the date and time of the printing. Regardless of the information encoded on the yellow dots, consistency throughout each print job is of value to the examiner. For example, if a ten-page document is printed on a cloud laser printer, then each of those ten pages will have the same yellow dot pattern. If a page is substituted, that page will have a different pattern. Furthermore, if a page is reprinted (adding a sentence or paragraph to the originally printed text) then there will be twice as many dots, indicating that the same page was processed/printed twice.

9.3.3 Paper

Chemical analysis of the paper will not provide a lot of interesting information, as continuous recycling has led to the use of the same pulp over and over again. Still, the paper type in a multi-page document can offer a way of alteration detection. For example, an eight-page contract that bears signatures only on the last page is contested, and one party claims page 6 has been altered. The colour of the paper (even the different tint of white), the weave of the paper surface, or even additional staple holes may hint at the substitution of an original page.

Furthermore, depending on the severity and the use of each document, additional security features may be used. The most common examples of paper documents full of security features are bank notes, bank cheques and passports.

A traditional way of embedding security features on documents going as far back as the 13th century is watermarking, which creates an image within the paper itself. The image is observable with the use of light transmitted through the paper itself. This feature is still used on all bank notes – such as exhibiting the head of the queen in UK notes.

Another feature commonly used in all aforementioned documents is ultraviolet ink. The bank logo with intrigue patterns is usually found printed with UV ink on bank cheques, information regarding currency is printed with UV ink on bank notes, and nearly all the information visible on a passport is also ‘hidden’ with the use of UV ink in other areas of that passport (including the cover).

UV ink is invisible under normal light, but when hit with UV light (electromagnetic radiation above the visible spectrum; specific wavelengths commonly used are 365 nm, 313 nm and 254 nm) it will absorb and re-emit that radiation near the visible spectrum and be observed. The use of UV ink is a helpful feature as it poses two problems to forgers: first, they have to know of its existence and be able to observe it; second, they have to be able to reproduce it.

A very good security measure that is encountered in highly important documents is microprinting, which consists of very small print of text that without magnification appears as a thick line. It is very difficult to detect unless one knows where to look, and can be found on the lines of bank cheques (usually one of the lines under the signature) and on lines on banknotes. Furthermore, microprinting is nearly impossible to copy with commercially available computer peripherals. The detail is too fine for a common computer scanner to detect, and even if that information was somehow fed into a computer, commercial printers cannot produce such microscopic printing in detail.

Other security features that are used include holograms, security metallic strips embedded in the paper (either visible, semi-visible or completely invisible) and UV fibres inside the paper itself.

Finally, the paper surface can provide an amazing amount of information if carefully examined. Writing by hand on a stack of papers creates indentations on the underlying pages of paper. The indentation is caused by the pressure of the tip of the writing instrument used, and passes by contact from the front page (the one that is written on) to those underneath. Indentations can be very subtle and invisible to the naked eye. A first approach to detect possible indentation involves the use of side light (i.e. a strong light source shining from the side of the document), but this method will reveal only the strongest indentations and does not go further than the first or second page.

A device known to document examiners for more than three decades that detects indentations is the ElectroStatic Detection Apparatus (ESDA™). The ESDA™ essentially involves a vacuum pump fixed in a metallic box, and a metallic plate (with holes) on top. The document is placed on the plate, a Mylar® film is set on top of it, and the configuration is held together by the suction from the vacuum pump. The surface of the Mylar® film is then electrically charged and the charges sit differently on the surface depending on whether there are indentations or a substance on the surface (existence of ink or printing). After that, toner particles are deposited on the surface and are held by the electrostatic field to those features that attracted the electric charges.

With this methodology, the ESDA™ can clearly reproduce indentations as deep as four or five pages, where they would no longer be visible to the naked eye. Such examinations can provide insight into case specifics and provide solutions to problems that cannot be solved with handwriting comparison alone. For example, an anonymous poison letter is brought in for examination. No specimen material is available because the author (or possible author) of the letter is not known. If the letter was written on a notepad, then the letter will carry the indentations from the writing on the previous pages of that notepad, possibly including information that leads to the author.

Additionally, line-crossing sequence, writing and indentation sequence or even fingerprint deposition and printing sequence can be investigated with the use of the ESDA™, as the subsequent writing or substance deposition sequence might be accurately depicted in the indentations left on the surface, and then picked up by the ESDA™ examination (Mohammed, 1998; Kalantzis, 2007; Fieldhouse *et al.*, 2009). Therefore the examiner can offer insight into whether all the writing was completed in one session, whether the indentations on a document were created before or after the writing on that same document, and whether the fingerprints detected on the document were deposited before or after printing.

9.4 Additional Issues Regarding the Evidential Value of Documents

Having covered the basics of the evidential value of documents, some issues have to be discussed.

9.4.1 Photocopies as evidence

Photocopies or computer-generated (and printed) reproductions of original documents

are essential to our everyday life and as such they are routinely encountered in the course of normal casework of a document examiner. Photocopies, reproducing all the visible information of the source document, can substitute for the original and, depending on the legal environment, in some countries they are treated as originals. Still, from the document examiner's point of view, the reproduced handwriting or signatures lack so many characteristics of the original that it increases the difficulty of the analysis and the forensic examination.

As mentioned earlier, handwriting and signatures are described by their pictorial and dynamic characteristics. The dynamic characteristics (i.e. pressure, speed, etc.) are lost in the reproduction process. The fluency of a written line, the accumulation of ink inside loops, feathering and other delicate features of the written line are not recorded by the photocopier and cannot be reproduced. Pen stops, corrections, retouching or small gaps in the written line may be reproduced as one solid (black) line depending on the model of the photocopier used, and therefore the reproduced signature (or handwriting) can be misleading in features of continuity, creating the danger of an erroneous conclusion if these flaws are neglected.

Still, the forensic examiner does not choose his cases nor his evidence, thus photocopies are often the only document evidence available.

The document examiner should be aware and should state in his report the aforementioned dangers of the examination of photocopies or reproductions. Then the examination should be based on the pictorial characteristics that survive the reproduction process. Photocopies are not stripped of any evidential value. For example, if a photocopied document bears a signature assumed to belong to Mr X, but which has no resemblance to the original signatures, then a conclusion of forgery (i.e. the questioned signature is not an original signature of Mr X) can be safely reached, *under the assumption that the examined photocopy is a faithful representation of the originally signed and photocopied document.*

When pictorial differences are spotted, it can be easy to reach a conclusion, as such differences are not expected to be overturned from the examination of the source document. On the other hand, if only similarities are spotted, then the document examiner is on dangerous ground. The fact that no differences are apparent from the photocopies does not mean that none exist – as mentioned earlier, pen pressure, pen stops, pen lifts, retouching, etc. is not reproduced in the photocopy, so all such information (if it exists) is lost. This situation makes it difficult to detect traced forgeries, but the real danger hides with altered documents.

Imagine the forger has access to a genuine signature. With modern equipment, he is able with relative ease to scan, crop and print the genuine signature, discarding the rest of the document it was signed on, and then reintroducing that genuine signature onto a new document. This can also be done (in a more crude manner) with scissors and sticky tape. As long as the product of this forgery is photocopied, the transfer of the genuine signature to a new document cannot be detected (unless the process was done without care and the forger left hints of his forgery, such as shadow lines from the cropping, etc.).

If the original product of such forgery is examined, it is very easy to determine the method used with a microscopic examination (that would reveal the signature was printed and not signed on the document). However, if only a photocopy remains, then all the surviving features point towards authenticity – as expected, since the reproduced signature has indeed originated from a genuine signature.

One common mistake encountered in such forgeries, which enables the examiner to identify it as such, is the use of the same signature again and again in the same or multiple documents. As mentioned earlier, each signature is unique, and no two signatures are 100% identical. This detail is unknown to most forgers who choose their source based on how 'genuine' they look. If the image of several signatures is identical then the only explanation is forgery.

9.4.2 Age and dating of documents

A very interesting and important aspect of document examination revolves around attempts to date documents and writing. Historical documents have many direct or indirect methodologies of being dated: based on the chemical examinations of paper and inks used; the composition of inks (much like similar examinations for authenticity of paintings, i.e. by analysing the components of the dyes and correlating that information with the assumed date of creation to determine whether these components were actually used during that time or not); with radiocarbon dating; or even stylistically, by examining the font system's compatibility with the assumed era of creation.

With modern documents, as briefly discussed earlier, the information deduced by such methodologies is inconclusive, due to the extensive use of recycling. For example, a last will and testament surfaces, dated 1 July 2007. The testator died in 2008 and no specimen material can be located. One party challenges the authenticity of this will, claiming that the other party forged it after a controversy over estates in 2013. The time difference in such a case would be only six years.

Depending on the inks used to create the questioned document, ink-dating methodologies can be used. As mentioned before, ink is a mixture of substances, some of which are volatile (able to evaporate). As ink is deposited from the ink cartridge to the paper surface, it starts drying. That drying process differs from ink type to ink type, but the most common methodologies apply to ballpoint pen ink, which dries out completely in about four to five years.

With chromatographic techniques (usually High Performance Thin Layer Chromatography, HPTLC) the different components of the ink mixture are identified, and their relative proportions are measured. The components are then referenced to curves of known aged inks and by comparison with the proper database, an estimate of the ink age can be achieved. There are two problems with such techniques: the time limit, meaning an ink cannot be indefinitely aged, as from some point on it is completely dry; and the ability to artificially age a document through heating, causing the more volatile components to evaporate more quickly.

9.4.3 Stipulation of conclusions

An important aspect of document examination and the introduction of documents as evidence in any procedure is the stipulation of conclusions. As the methodology used in handwriting and signature comparison is not a quantitative one, but qualitative, the wording used has to correspond to a context understandable and accessible by all. For example, a signature is questioned as a forgery, and the examination exhibits a majority of similarities, but includes some differentiations from the specimen material, which can be explained and are not significant enough to challenge the authenticity of the signature. In such a case the examiner will not reach a conclusion with the highest certainty, but will express his conclusion regarding the authenticity of the signature with the use of words such as 'possible', 'very high probability', etc. These words, even though familiar to the layperson from everyday activities, do not correspond to a comprehensive scale of conclusions.

Efforts have been made by several countries and government agencies to create and adopt a standard form of conclusion reporting, and what they all have in common is that an explanation of the context descriptive to the specific case needs to follow the phrasing of the conclusion, regardless of the phrasing itself. For example, the currently used German scale (Köller *et al.*, 2004) uses the following wording and context steps.

- Probability bordering on certainty: The entire configuration of findings compiled, discussed and assessed as having high evidential value is in complete conformity with the hypothesis in all respects.
- Very high probability: The entire configuration of findings compiled, discussed and assessed as having high evidential value is in complete conformity with

the hypothesis in all respects. Findings which are not completely concordant and in no way relevant can be explained on the basis of method.

- High probability: The entire configuration of findings compiled, discussed and assessed as having sufficient evidential value is largely consistent with the hypothesis. Minor findings-related, irrelevant restrictions and/or inadequacies attributable to material are insubstantial and can be explained and justified on the basis of method.
- Predominant probability: The entire configuration of findings compiled, discussed and assessed as having sufficient evidential value is in agreement with the hypothesis in many respects. Findings-related, irrelevant restrictions and/or inadequacies attributable to material are insubstantial and can be explained and justified on the basis of method.
- Slightly predominant probability: The entire configuration of findings compiled, discussed and assessed as having meaningful evidence value conforms with the hypothesis but not entirely without inconsistency. Findings-related, restrictions and/or inadequacies attributable to material are significant and cannot be explained entirely on the basis of method.
- Indifferent probability – *non liquet*: The entire configuration of findings compiled and discussed is contradictory and does not support the identification of a tendency with respect to conformity with the hypothesis. Findings-related, restrictions and/or inadequacies attributable to material are significant and cannot be explained sufficiently on the basis of method.

In 2013, the European Network of Forensic Handwriting Examiners (ENFHEX), part of the European Network of Forensic Science (ENFSI) began to establish a uniform system of reporting conclusions for use of member laboratories (government and private) throughout Europe. The consequences of this effort could lead to consistency in reported results from European laboratories and examiners.

References

Berger, M.A. (2005) What has a decade of *Daubert* wrought? *American Journal of Public Health* 95(S1), S59–65.

Brunelle, R.L. and Crawford, K.R. (2003) *Advances in the Forensic Analysis and Dating of Writing Ink*. Charles C. Thomas, Springfield, Illinois, USA.

Caligiuri, M.P. and Mohammed, L.A. (2012) *The Neuroscience of Handwriting*. CRC Press, Boca Raton, Florida, USA.

Fieldhouse, S., Kalantzis, N. and Platt, A.W. (2009) Determination of the sequence of latent fingermarks and writing or printing on white office paper. *Forensic Science International* 206(1–3), 155–160.

Found, B., Sita, J. and Rogers, D. (1999) The development of a program for characterizing forensic handwriting examiners' expertise: signature examination pilot study. *Journal of Forensic Document Examination* 01(12), 69–80.

Furnham, A. and Gunter, B. (1987) Graphology and personality: another failure to validate graphological analysis. *Personality and Individual Differences* 8(3), 433–435.

Hecker, M.R. (1993) *Forensische Handschriftenuntersuchung: Eine systematische Darstellung von Forschung, Begutachtung und Beweiswert*. Kriminalistik Verlag, Heidelberg, Germany.

Hussong, J. (2001) Case study: graffiti. Paper delivered at the 5th International Congress of the Gesellschaft für Forensische Schriftuntersuchung (GFS) e.V., Bingen am Rhine, Germany (not published).

Jennings, D.L., Amabile, T.M. and Ross, L. (1982) Informal covariation assessment: data-based versus theory-based judgments. In: Kahneman, D., Slovic, P. and Tversky, A. (eds) *Judgment under Uncertainty: Heuristics and Biases*. Cambridge University Press, Cambridge, UK, pp. 211–238.

Kalantzis, N. (2007) The use of the Electrostatic Detection Device (ESDA) in the forensic examination of documents. *Penal Justice/*Ποινική Δικαιοσύνη 12(December), 1449–1454 (in Greek).