

Journal of the American Society of Questioned Document Examiners

Volume 1, Number 1

ABSTRACTS

1. Foreword
Janis M. Winchester, Editor

This inaugural edition of the *Journal of the American Society of Questioned Document Examiners* represents a new step in the field of Forensic Science. We are pleased to provide a peer reviewed compilation of papers presented at forensic science meetings, original research and technical notes concerning the field of Forensic Document Examination. Many individuals have contributed to the accomplishments of this first edition. Pulling together a new Journal requires a considerable amount of coordination. We appreciate the authors whose works are represented in this issue, and look forward to presenting the other scientific papers that are still in progress in future editions.

2. Editorial: A Brief History of the American Society of Questioned Document Examiners
James V. P. Conroy

The American Society of Questioned Document Examiners (ASQDE), formally established on September 2, 1942, is the oldest and most prestigious organization of questioned document examiners in the United States. The first president and primary organizer of the ASQDE was Albert S. Osborn. Mr. Osborn is considered by many to be the father of the scientific examination of questioned documents in the United States. His *Questioned Documents*, first edition 1910, and *The Problem of Proof*, first edition 1922, were widely acclaimed by the legal profession, and public and private agencies concerned with promoting justice in matters involving questions about documents.

3. The Uniqueness of Handwriting
Thomas Vastrick

Forensic document examiners have recently witnessed three events that have raised questions, either directly or indirectly, about the basis for handwriting identification, specifically in the areas of the statistical and scientific basis for the uniqueness of handwriting. These events consist of the publication of an article titled *Exorcism of Ignorance as a Proxy for Rational Knowledge: The Lessons of Handwriting Identification Expertise*, by D. Michael Risinger, Mark P. Denbeaux and Michael Saks (137 U.Pa. L.Rev. 731, 1989), the recent Supreme Court decision of *Daubert v. Merrell Dow Pharmaceuticals, Inc.* 113S. Ct. 2786 (1993) (along with the subsequent affect on federal and state rules of evidence), and the results of the "Daubert" hearing preceding the hearing of *United States of America v. Robert and Eileen Starzecpyzel* 93 Cr. 553.

4. The Identification of Colour Photocopiers: A Case Study
C. K. Li and S. C. Leung

This paper reports the discovery of dotted patterns on photocopies of Hong Kong \$500 banknotes seized in a clandestine workshop and the utilization of the matrix of dots for the identification the Rank Xerox colour photocopying machine used for counterfeiting the banknotes. A survey on various models of colour photocopies of the Canon and Ricoh brands resulted in the observation of dotted motifs on photocopies from the high-ended models of the Canon copiers. These dotted motifs are probably also identification marks.



5. Discrimination of Ballpoint Pen Inks by High Performance Capillary Electrophoresis and High Performance Liquid Chromatography
T. D. Whiting

Previous research demonstrates that Capillary Zone Electrophoresis has been successful in discriminating between various writing inks, including those found in felt tip and fountain pens. This preliminary study demonstrates ballpoint pen inks being discriminated using High Performance Capillary Electrophoresis (HPCE). Ballpoint pen inks were also tested using High Performance Liquid Chromatography (HPLC) and the results compared with those obtained from HPCE. Methodologies for sample preparation of four black ballpoint pen inks were developed to test a Beckman P/ACE System 5000 for HPCE and a Waters 712 WISP millipore injector system for HPLC. The initial data from HPCE and HPLC consistently differentiated between the four black ballpoint pen ink samples. The advantages of HPCE over HPLC include lower operating costs and the use of buffers rather than solvents. Further research in HPCE and ballpoint pen inks should provide an effective document examination tool for the discrimination of ballpoint inks.

6. The Effect of Sunlight and Fluorescent Tube Light on Inks and Papers
Marta E. Vos, Steven J. Strach, and Paul D. Westwood

Following a case involving claimed sunlight effects on paper and ink, and a document examination conclusion suggesting chemical erasure, paper, and ink from various sources were subjected over various periods of time to radiation from sunlight through a window and to radiation from a room fluorescent tube light. All of the papers tested showed a darkening, and most showed a reduction of UV stimulated blue luminescence (fluorescence) and blue light stimulated red luminescence following exposure to sunlight. All of the inks showed changes in apparent optical absorption of light following exposure to sunlight, with some showing dramatic changes in colour, infrared absorption, and luminescence properties. None of the papers or inks tested showed any detectable change upon exposure to the fluorescent tube light. Document examiners should be aware of environmental effects such as sunlight causing changes in the optical properties of paper and inks which potentially might be misinterpreted as a difference in type of paper or ink, or wrongly ascribed to the effects of chemical erasure.

7. Pen Pressure as an Identifying Characteristic of Signatures: Verification from the Computer
Peter V. Tytell

In the spring of 1975 the author noted a product announcement from Sentracon systems in a trade publication:

Security System Identifies Signatures by Pressure

Access control through new SIGNAC system is dependent on a measure of pressure patterns in individual signatures. System consists of a pen, pen signal processor, controller/enrollment console, and a central processing unit. New signatures are entered into the central memory and paired with a code number. From then on, access to computer records, security areas, and other system-supervised materials is requested by punching in the digital code at any terminal/processor and signing any piece of paper with the connected pen. Forgeries cannot duplicate the hand pressure of the signatory, even with a perfect duplication of the written name. ["Security System," 1975]

8. A Study of the Evolution of Handwriting from Grades Three to Six
Sandra L. Ramsey



There are several complex factors that contribute to the uniqueness of one's writing. A research project was conducted to evaluate the validity of three long accepted premises of handwriting identification. Specimens of handwriting were obtained from one third grade class of students in the 1993-1994 school year, followed by additional handwriting specimens from these same students in grades four, five, and six. These writings were examined with regard to frequency of specific features, styles of writing, variation, and individuality. The findings support the premises of handwriting identification: (1) no one can write above their skill level; (2) no writer can write the same text exactly the same way twice; and (3) no two writers write exactly alike.

9. Sequencing Writing Impressions and Laser Printing or Inkjet Printing Using the ESDA
Linton A. Mohammed

This study investigated the possibility of determining the sequence of writing impressions and inkjet or laser printing using the Electrostatic Detection Apparatus (ESDA). It was found that the sequence of impressions and inkjet printing could be determined with a high degree of confidence. The sequence of impressions and laser printing could not be determined in the study.

10. Problems with the Differentiation of Rubber Stamp Ink Signature Impressions and Written Signatures
Paul D. Westwood and Robert W. Radley

In most cases, the forensic document examiner has little difficulty in recognizing a signature impression created by use of an inked rubber (or plastic) embossed stamping device and distinguishing it from a signature written with a liquid ink pen. When such signatures appear on paper bearing a fine complex printed background (such as security printing) the distinguishing features can be less clear cut and in some cases ambiguous. This paper lists the features which may serve to distinguish "rubber" stamp signature impressions from written signatures and discusses how complications such as a printed background can affect the distinguishing features.

11. Edge Characteristics of Commercially Produced Paper Stock
William J. Bodziak

The commercial production of paper items still involves the use of large guillotine blades to cut through thick stacks of paper stock, tablets, notebook filler paper, steno pads, and similar paper products. During the sharpening process and subsequent use, the blades acquire grind marks and nicks, and as a result, take on their own uniqueness. Depending on the thickness, type of paper stock, and frequency of use, these blades must be sharpened relatively frequently. When the blades are removed and sharpened, their unique features are removed. New grinding marks from sharpening and, upon use, a new set of unique random nicks now distinguish that blade from its prior characteristics as well as from other blades. A study of two paper cutting machines and processes at a large paper company was made to determine if more than one pad can result in identical edge features on each of the four sides. The process each machine uses to cut paper stock, the edge characteristics which result from the guillotine blade, and the likelihood of duplicate features are discussed. In addition, a method of photographing the microscopic features which remain on the edges of cut paper stock is discussed and illustrated. This information should assist the document examiner during comparisons of individual pieces of paper for the purpose of confirming common origin.

12. Review of "Handwriting Identification Evidence in the Post-Daubert World"



F. L. Lee, Jr.

Moenssens, A. "Handwriting Identification Evidence in the Post-Daubert World," Vol. 66:2 UMKC L. REV. 251 (1997). Moenssens, has over 30 years experience as a professor of law, is a trial lawyer, a Fellow of the American Academy of Forensic Sciences and is an internationally recognized consultant on forensic science issues. This experience has uniquely equipped him to conduct this discussion on the standards needed for "scientific knowledge," the reliability of the science of questioned document examination, and the admission of handwriting expert testimony by the courts post-Daubert.



Journal of the American Society of Questioned Document Examiners

Volume 1, Number 2

ABSTRACTS

1. Foreword
Janis M. Winchester, Editor

Forensic Document Examiners provide Expert Witness testimony in courts of law presenting demonstrative proof concerning the fact that a document is genuine or forged. Thorough grounded training of the Forensic Document Examiner is required for the scientific analysis of handwriting, hand printing, and various seen or unseen qualities of the document. The presentation of the findings in court assists the Judge and Jury in their deliberations concerning the guilt or innocence of an individual.

2. An Investigation into the Degree of Similarity in the Handwriting of Identical and Fraternal Twins in New Zealand
David Boot

A document examination case involving the handwriting of identical twins showed a striking degree of similarity in their handwriting. Following this observation, research was undertaken to gauge the degree of handwriting similarity in a larger sample of identical and fraternal twins' handwriting. Handwriting samples and questionnaires allowed the investigation of factors such as genetically linked similarity, schooling, and handedness. The results showed that none of the twins wrote exactly alike, however in some cases there was a marked degree of similarity. No evidence was found to suggest that identical twins write with more similarity than fraternal twins. While the effect of genetic factors on handwriting could not be truly judged, the study did highlight the need for care and thoroughness in any examination of handwriting.

3. Flat Die Stamps: A New Technology from Brother
Jan Seaman Kelly

The traditional manufacturing processes of stamps produced a stamp with a relief on the die. Brother has created the SC-2000 (Stampcreator Pro) and the SC-300 PC that manufacture stamps with a flat die, i.e., no relief. The purpose of this paper is to describe the process and evaluate the features or characteristics that separate stamps made by the Brother stamp units from stamps made by more traditional manufacturing processes.

4. Classification of Ink Jet Printers and Inks
Paige Doherty

This study evaluates and compares ink samples from current and discontinued ink jet printer models in an effort to classify and date the formulations of ink. The physical and chemical properties of black ink samples printed with 18 types of cartridges (used in 32 different printer models) and unprocessed samples from eight black ink cartridges were analyzed. This research found that: (1) processed and raw inks from the same model cartridges produced varying spectral results and consistent chemical results, (2) many of the inks could be differentiated and classified, and (3) the limited sampling of inks available for dating could be correlated to an introduction or revision date.



5. Survey of Techniques Used to Visualize Indented Markings
Jerry L. Brown

This is a review of information and techniques utilized to visualize indented markings on paper. This information is intended only as a survey, providing highlights of the different techniques used to visualize indented marks and text. The main reason for this survey is that since its introduction, the Electrostatic Detection Apparatus (ESDA) is the method of choice for visualizing indented marks. The ESDA is not the panacea for all indented impression problems, but it is easier than whatever is second. Sometimes other methods of inquiry into visualizing indentations may be necessary to come up with needed answers.

6. Using the ESDA to Visualize Typewriter Indented Markings
Jerry L. Brown and Gary Licht

Forensic Document Examiners look at papers that may contain indented typed impressions. Normally, these impressions can be seen during the visual examination of the questioned document. One way to process this type of document is to use the Electrostatic Detection Apparatus (ESDA), Electrostatic Vacuum Box, or Indentation Materializer. The ESDA examination results in a darkened sheet of imaging film, but no developed indented impressions of the typed material.

7. Cause of Typewriter Printwheel Damage Observed in the Questioned Document
Donald D. Moryan

Typing defects are used during an examination to identify a questioned element as to the method being used to produce a questioned document. Damage and wear of the typescript can be seen under magnification. This is a case study of an unusual cause of typeface damage to a printwheel, which was observed on a questioned document.

8. Preparation of Court Charts Through Digital Imaging
L. Keith Nelson and A. Frank Hicks

In order to demonstrate their findings in a court of law, Forensic Document Examiners frequently prepare enlargements of the signatures or other handwriting that has been examined. This can be a very time-consuming process if photography is used. The authors present an alternative to this method that uses digital imaging with a computer to more quickly prepare professional-looking charts. In addition to the handwriting images, the charts can be supplemented with annotations such as arrows and text, both of which can be colorized if needed.

9. Historical Review
John Paul Osborn

The field of forensic document examination has a rich history. Particularly in the early 1900s, before expert testimony concerning the identification of writing and other aspects of this discipline were readily accepted by courts in the United States, the pioneers of this field had the daunting task of proving its worthiness and usefulness to deciders of fact. Among those pioneers was Albert S. Osborn.

10. The Relation of Light to the Proof of Documents
Albert S. Osborn



I can think of no association that bears a name which affords such a temptation to the manufacture of figures of speech as an Illuminating Engineering Society. The name at once suggests the dark places that need your assistance. Every department of human activity does indeed need illuminating engineers and what we all want everywhere and all the time is more light. Light is an important factor in the proof of documents and light engineers can promote justice by making it easier to prove the facts regarding disputed documents. Anything relating to the subject of illumination that affects the quality of human vision is of vital importance in all forgery investigations.

Journal of the American Society of Questioned Document Examiners

Volume 2, Number 1

ABSTRACTS

1. Foreword

Janis M. Winchester

It is interesting to review the historical perspective of the first women in the field of Forensic Document Examination, as detailed in the article by Forensic Document Examiner (FDE) Jan Beck. These pioneering women entered the profession at a time when society, particularly the role of women, was undergoing change. Then as now, the training process followed the accepted practice of apprenticing with established and well-regarded document examiners.

2. It's Palm, Not Palmer

Rose Karpel

Character recognition technology for handheld computers often incorporates the use of novel systems of writing. This paper describes the Graffiti® writing system used with the PalmPilot series of handheld computers and its implications for forensic handwriting examinations. As the writer becomes accustomed to using Graffiti®, certain characteristics may carry over into non-Palm writing. Handheld computers are becoming part of daily life, and the writing systems used with them, like Graffiti®, may become part of a Forensic Document Examiner's workload.

3. Class Characteristics of Hand Printing

Ellen Mulcrone Schuetzner

In an examination of hand printing, it may be necessary for the Forensic Document Examiner to check standards of hand printed systems. This paper catalogs 38 identified systems of hand printing. Upper and lower case letterforms are drawn out and labeled according to an identified copy book system of hand printing.

4. Normal Course-of-Business Records versus Manufactured Records

Sandra Ramsey Lines, Jan Seaman Kelly, and Diane K. Tolliver

In the case of handwritten business records, the Forensic Document Examiner (FDE) compares a disputed or questioned record with "normal course-of-business" records. A comprehensive examination of the factors observed in the record is considered. The totality of what is found, and often what is not found, may permit a definite conclusion with respect to whether or not the business record was prepared in the "normal course-of-business," or manufactured in a manner not consistent with "normal course-of-business" practices. The data collected as part of this study supports the literature on examining business records by the recognition of specific factors when examining business records using a comprehensive checklist.



5. Survey of Handwriting Habit Areas Used by Forensic Document Examiners: Degree of Use and Discriminatory Power
Richard C. Hanlen, Patricia A. Manzolillo, Robert J. Muehlberger, and Grant R. Sperry

In April 1998, a survey was distributed to Forensic Document Examiners (FDEs) requesting an evaluation of the habit areas used and their utility in distinguishing handwriting. The information obtained from this survey was intended to provide the data necessary to select a preliminary set of characteristics for analysis. It is important to use these relative rankings as an indication of general tendency and possible discriminatory dominance as compared to an absolute ranking of discriminatory dominance over the other habit areas. The particular circumstances surrounding the examination of handwriting can dictate a far different ordering of habit areas.

6. Katherine Applegate Keeler Dussaq: The First Woman Document Examiner
Jan Beck

This historical overview of the life of Katherine Applegate Keeler Dussaq describes the early advances of the field of Forensic Document Examination, and the development of the first Crime Laboratory.

Journal of the American Society of Questioned Document Examiners

Volume 2, Number 2

ABSTRACTS

1. Figuring It Out
Audrey Giles

Identifying records of drug dealing transactions inevitably leads to the examination of scraps of paper bearing only figures. In order to assess how variable individuals are when writing figures, a number of writings were classified and the number of variations assessed. Some figures, for example, the figure 4, proved to be a better indication of authorship than others.

2. Diode Array Micro Spectrometry of Colour Ink-Jet Printers
Williams David Mazzella

Ink-jet printed documents, produced on 70 different brands and models of ink-jet printers available on the European market were analyzed by a micro spectrophotometer (reflection mode) using a diode array detector. The research focused on the measure of the reflection spectrum between 380 and 760 nm. Only the magenta and the cyan colours were measured since the yellow, according to a preliminary study, does not have a significant variation and subsequently was not analyzed. For each colour analyzed, three measurements were made and the mean was calculated. The results obtained enabled us to create a database. Such a database can be used to identify a particular model of printer (or group of models) used to print a forged or counterfeit document. The problems encountered due to the paper stock and compatible ink cartridges (non-OEM cartridges) are also discussed.

3. A Close Look at the Significance of Margin Drift: What Does It Really Tell Us?
Robert Bey and Dennis Ryan

Many times the Forensic Document Examiner (FDE) is called upon to examine documents where there are multiple signatures of one individual. The question put forth to us as experts is, "Were these signatures executed at one sitting or were these signatures written on different occasions?" In order to answer this question, an FDE may look at a phenomenon called "margin drift" and use this as a factor in arriving at their conclusion. The critical problem that arises for the FDE is: How much weight do we give to this phenomenon? Moreover, can margin drift be a significant factor in indicating that a group of signatures were written during one sitting? This is the problem put forth in this paper.

4. A Review of the Spectrometer and Chromaticity Capabilities of the VSC 2000
Tobin Tanaka

Differences between inks are often observed by Forensic Document Examiners (FDEs) through the use of infrared (IR) reflectance. Such differences are observable in real time with CCD cameras and appropriate filters on such coupled instruments offered by Projectina and Foster + Freeman. These differences in IR reflectance are usually observed and distinguished through qualitative analysis. Until recently, quantitative analysis could be accomplished but would require extension manual collection of data, subsequent statistical processing, and plotting of data points. The VSC 2000 offers an automated system which yields quantitative data useful in the discrimination of inks. A brief explanation of the utility and limitations encountered will be discussed.



5. Shandon Xylene Substitute in Document Examinations
Gary Licht and Jerry Brown

A variety of practical applications were found for Shandon Xylene Substitute in the examination of questioned documents. This product is marketed as a non-carcinogenic substitute for xylenes, but does not have quite the same properties. The most useful properties of this xylene substitute are that it is non-destructive to inks, paper and plastics, is less volatile than xylene, and is only a weak solvent of correction fluids. Its principle uses here have been to make paper translucent, thereby allowing obliterated writings to be read through the back side of the page. This translucent state also allows infrared examinations through the paper. Applications were made to cases involving obliterations made with correction fluids, overwritings, ink, and multiple layers of these materials. Shandon Xylene Substitute does not affect indented writings and ESDA examinations. It evaporates without leaving any odor, discoloration, or distortion.

6. A Method for Determining the Condition of an ESDA or IMEDD
Dan Purdy, B.Sc., F.S.S. Dip.

Many document examiners have taken steps to prepare their laboratories for accreditation. One important requirement of this process involves the testing of equipment to ensure it is in good working order and capable of providing quality results. Two instruments used to decipher indented impressions on paper are the Electrostatic Detection Apparatus (ESDA) and the Indentation Materializer Electrostatic Document Device (IMEDD). The results produced by these instruments can vary due to a number of causes including: unfavourable ambient conditions (low relative humidity), weak corona discharge, a dirty corona wire, insufficient application of toner and weak pressure generated by the vacuum pump. A simple device is described that enables the ESDA or IMEDD operator to repeatedly produce constant impressions on paper test strips. The test strip is subjected to the same experimental conditions as the questioned document and is placed on the platen each time the instrument is used. The degree to which impressions on the test strip are recovered is a function of the ambient conditions and the instrument's condition. If test results lie outside an acceptable range, the instrument must be repaired or the test postponed until environmental conditions are favorable.

7. ESDA Cascade Developer
Melvin Henry Cavanaugh, Jr., Barbara L. Torres, and Wesley P. Grose

This paper provides additional information for use of the ESDA.

8. Write-On™: A New Tool for Handwriting Comparison
Linton A. Mohammed

Write-On™ is an innovative software program that was developed to aid document examiners in cases that include extended handwriting. Searches for comparable words, letter combinations, and characters can be done. The results of these searches are documented and they can be used to develop statistical data to support the analysis and opinion. The program's chart-making facilities are a sophisticated alternative to traditional cut-and-paste techniques. Write-on™ is quite versatile and can be used in cases consisting of two documents or hundreds of documents.

Journal of the American Society of Questioned Document Examiners

Volume 3, Number 1

ABSTRACTS

1. The Heterogeneity of Handwriting
Roy A. Huber

The practice of handwriting identification has been criticized by the judiciary of late for not providing the empirical data in support of its claims for the uniqueness of writing and the significance of its discriminating elements. This investigation is an endeavor to satisfy the requirement by describing a study of a collection of nearly 1000 writers executing similar writing standards in which many of the normal variables have been controlled. With the exception of two writers who were professional penmen, no difficulties were encountered in discriminating between writers. Owing to the range of natural variation in some individuals, however, it is possible that there may be a few specimens in the collection having common authorship that have not been appropriately associated by the limited selection of discriminating elements employed in the study. Suffice it to say, this kind of error does not lead to inaccuracies in writer identification. The frequency of occurrence reported of the discriminating elements selected provides some indication of their relative significance.

2.
Gerhard W. Wendt, M.S.

In an effort to expand on the knowledge of signature disguises most commonly used by writers, 128 state police cadets were given a survey instrument and asked to provide signature exemplars. These cadets were then instructed to disguise their normal signatures. A comprehensive index of seventeen different disguise methods was utilized to analyze what techniques of deception had been employed by each writer. While previous research regarding the relationship between education and disguise was directed towards extended handwriting, this study focused on the effects of education on disguise in signatures. From the data collected, most subjects used between one and three methods of disguise with the most popular method being "*altered capital letters*" in disguising their name. A weak relationship was noted between education and the writer's ability to successfully disguise his/her signature. Additional findings are discussed in the study. The information from this study should prove useful for forensic documents examiners encountering the phenomenon of disguise in a questioned signature.

3. Identifiability of the Flatbed Scanners and Its Products (Graphic Files and Printed Results)
Richard A. Horton, BS, M.Ed.

This study addresses the ability to identify the specific original document, scanner or graphics file from which a scanned product (graphics file or printed result) was made. Contaminants in many types of paper are often reproduced by the scanner, allowing a correlation of the product to an original document. Further, Small Computer Systems Interface (SCSI) chain noise (interference) frequently produces a non-repeating series of marks allowing a graphics file to be correlated to a printed result. Photocopier-type defects from the scanner platen and internal components may also allow the correlation of a specific scanner to a printed result.

4. Retail Price Marking Devices: Breakaway Slits and Type Fonts
Joyce A. Lauterbach

There are currently four major manufacturers and/or distributors of hand-held pricing guns and labels. A fifth manufacturer makes a generic pricing gun and label that may be marketed under the name of several distributors.



Class characteristics of labels manufactured by each company depends primarily on recognition of the design of tamper-proof or break away slits, and recognition of the standard font style for numbering.

5. A Study of Hmong Handwriting
 Janis S. Tweedy

The handwriting of Hmong people who learned to write in Southeast Asia was collected and studied to see if there were any class characteristics or unusual habits present in the writing that could identify it as having been produced by a Hmong writer. Of interest is the fact that the Hmong people had no written language before 1953 when one was developed for them that uses the Roman alphabet. No identifiable class characteristics or habits were identified. However, a large percentage of the writers used more hand printing or penlifts than normally encountered by the author.

Journal of the American Society of Questioned Document Examiners

Volume 3, Number 2

ABSTRACTS

1. Measuring Relative Pen Pressure to Authenticate Signatures
Colin Estabrooks

This study exploits the capacity of the confocal laser scanning microscope (CLSM) to accurately measure the z-axis of pen pressure indentations in paper. Depth values measured at various sites of signatures are compared to the maximum depth of each signature. By measuring these “relative” depth values of multiple genuine signatures, a writer’s master pattern of pen pressure emphasis can be uniquely portrayed in a quantified manner. “Relative” depth values of simulated and traced signatures are similarly measured and are generally found to be clearly distinguishable from genuine signatures.

2. The Effects of Latent Print Processing on Ballpoint Pen Inks
Richard A. Horton and Lyle C. Shaver

Latent print (LP) processing and subsequent examination of twenty-five ballpoint inks revealed significant changes in ultraviolet fluorescence (UVF), infrared luminescence (IRL) and infrared reflectance (IRR) that could result in the incorrect identification or elimination of an ink when addressing alterations, multiple authorship, or comparing a specific pen to questioned entries. The inks were processed with three common ninhydrin solutions, then processed with physical developer. Subsequent examination revealed frequent dequenching of UVF and IRL, as well as changes to IRR properties and visible color. Thin-Layer Chromatography (TLC) plates were run for fifteen inks, but did not reveal any significant changes to inks after LP processing. Sometimes there were little or no visible signs of LP processing, suggesting police departments should notify examiners if they process documents for LPs prior to submission.

3. Choosing Cascading Beads for the Electrostatic Detection Apparatus
Bonnie L. Beal

The Electrostatic Detection Apparatus cascade developer beads become pitted or roughed up over time and lose the ability to attract toner, thereby lessening the effectiveness of the cascading beads. After viewing the Electrostatic Detection Apparatus beads under a microscope it was decided to replace them with newer beads. At this time an experiment was undertaken using two different size beads. Foster and Freeman beads and sandblasting beads were used with the latter being the smaller of the two types of beads. The smaller sandblasting beads developed the indented images better.

4. Common Chemicals for Common Criminals: Check Washing Again
Gary Licht

The removal of several types of pen inks from personal checks is a simple process for the person who is willing to acquire checks that have been legitimately written. Using checks that have been written by the check owner provides the check washer with a model signature for each stolen check that is to be washed and rewritten. This can be confusing to the check owner when the check is finally processed at the home bank, since many bank personnel and customers can’t recognize a traced signature as non-genuine. The crime involves passing bad checks that have been stolen from places such as home mailboxes and United States Postal Service mailboxes. This paper will discuss the parameters of washing ink from checks with common chemicals found in paint stores, hardware stores, and automotive parts stores. Some of these parameters are; what inks do and don’t wash off without destroying the check, what chemicals may be used, how the new signatures are created, and what a questioned document examiner may find in the finished product.



5. The Examination and Demonstration of the Presence of Paper Fiber Patterns on Carbon Film Ribbons
Using the Ken-A-Vision® Video Flex® Digital Camera
Brian B. Carney and Derek L. Hammond

Forensic Document Examiners (FDEs) often utilize various instruments to assist them in the examination of questioned documents and to prepare demonstrative charts to illustrate their findings. Unfortunately, many of these instruments are uneconomical and are limited in their capabilities in that they can only be used for a single purpose. Recently, a more versatile instrument, the Ken-A-Vision Video Flex digital camera, has become available and is finding its way into the arsenal of the forensic scientist. Utilizing the Video Flex, the authors tested a new method for the examination and demonstration of paper fiber patterns on carbon film ribbons. This device not only assisted the authors in their examinations, but also provided a means to easily demonstrate the subsequent findings.

Abstracts

Volume 4, Number 1

Secondary Impressions (Andrew J. Barton and John D. S. Walker)

This paper provides a summary of available information relating to secondary impressions and additional findings gained through experimentation done in the New Zealand Police Document Examination Section. The culmination of this information is aimed at providing a reference to identifying the types of conditions that lend themselves to the formation of secondary impressions and, furthermore, to note any features that distinguish these secondary impressions from indentations.

Applying Specific Digital Enhancement Techniques to ESDA-Developed Impressions

(Grant R. Sperry and Diane K. Tolliver)

The ESDA (Electrostatic Detection Apparatus), IMEDD (Indentation Materializer Electrostatic Document Device) and other instruments and techniques are employed routinely by Forensic Document Examiners (FDEs) in an effort to locate, decipher and preserve indented writings or impressions. The impressions developed on the polymer film sheet using the ESDA or IMEDD, regardless of technique, will frequently be less than optimum and defy successful decipherment and/or poor legibility. A study was conducted to determine whether the use of specific digital enhancement techniques significantly improved the legibility and decipherment of impressions developed by the ESDA on polymer film. The results of this study will be presented as well as the specific techniques that were utilized.

Evaluation of Ozone Exposure from Use of the Electrostatic Detection Apparatus (Mark Cameron)

Use of the Electrostatic Detection Apparatus in evaluating documents for hidden indentations creates ozone. Ozone can cause respiratory irritation and breathing difficulty. Ozone discharge was measured for an hour during continuous operation at two different locations. Results indicated that continuous use can generate ozone concentrations that will exceed the permissible exposure limit mandated by the Occupational Safety and Health Administration. Ozone levels can be controlled by shutting the corona wand off when not in use and by using local exhaust ventilation.

Manufacture of Pirated Compact Discs in Hong Kong

(Yau-Sang Cheng, Chi-Keung Li, Pui-Shing Hung)

Compact discs (CDs) have gained popularity as a recording medium since the early 1980s. Owing to the low production cost and high profit margins, the medium has been a target for pirating by the clandestine "industry." This paper briefly describes the manufacturing process of a compact disc, and the identification methods used to relate a pirated CD with the stampers, mold heads and printing screens found in the clandestine CD factory. Characteristic defects introduced during the various stages of the production process, namely, the molding, design and printing, all offer excellent potential for comparative examination.

Printing Defects on Three-Ring Notebook Paper (Richard A. Horton)

This paper addresses the significance of printing defects in the margin lines and horizontal lines of typical notebook paper. A brief overview of notebook paper printing and assembly is provided. Two cases involving defects on sheets of notebook paper are discussed.

Abstracts

Volume 4, Number 2

Class Characteristics of Counterfeit Protection System Codes of Color Laser Copiers

(Janis S. Tweedy)

As the quality of the color laser copiers increased at the end of the 1980s, it became apparent that they could be used to produce credible copies of important documents. In an effort to stop their use as a counterfeiting tool, changes were made to the machines to prevent the copying of important documents as well as to identify the color laser copier used to make the copy through the inclusion of a code on each color laser copy. Submitting the copies to the U.S. Secret Service Laboratory can allow for decoding to identify the make, model, and serial number of the copier used. However, by studying the code present on a color laser copy, a forensic document examiner may determine the possible manufacturer of the color laser copier used to produce the copy which may be useful as investigative information. Also, the forensic document examiner can identify a color laser copier as the one used to produce questioned copies if the questioned copies display the same code as produced by the known color laser copier.

Digital Reconstruction of Torn Paper

(Derek L. Hammond)

Utilizing current digital technology, specifically Adobe® Photoshop®, a technique is described to assist Forensic Document Examiners in the reconstruction of torn paper. The methodology described overcomes the shortcomings of previous methodologies while maintaining the integrity of the evidence for future forensic examinations/comparison.

The Israel Police's Experience with Official Documents from the Soviet Union

(Sharon Brown, Avi Abulafia, Rachel Gabbay)

This article reviews three types of official documents issued by the former Soviet Union, namely, driving licenses, birth certificates and nursing diplomas. The change in formatting of these documents over the years is described, including background prints, security features and details of how the personalia are entered. A description is given of the most common forgeries encountered in the authors' laboratory for each class of document.

Historical Review: Some Basic Rules for the Identification of Handwriting

(Ordway Hilton, with introduction by Farrell Shiver)

The rules and corollaries stated in this paper represent some of the basic concepts necessary for accurate identification of handwriting. Rather than attempting to include all conceivable rules, the more important have been selected. Their full comprehension may assist students in becoming proficient in the examination of handwriting but they are far from a cure-all. The accurate identification of writing requires the interpretation of all physical facts found within the writing not only in the light of these rules but also with intelligence and common sense. It is essential to understand how writing is produced and what physical facts result from each and every writing movement. Only then can accuracy and proficiency be attained.

Abstracts

Volume 5, Number 1

Determining the Sequence of Non-Intersecting Media on Documents: Ballpoint Pen Ink and Laser Toner

(Valery N. Aginsky)

This paper describes a technique for establishing the sequence of ballpoint ink entries and laser-printed entries in instances when these entries do not intersect.

An Instance of Inkjet Printer Identification

(Joseph L. Parker)

Examination of a series of anonymous documents generated by inkjet printer technology, revealed the presence of several printing flaws. A suspect inkjet printer was received for examination. Test printing with the suspect printer reproduced the same flaws observed on the questioned documents. Examination of the suspect machine, and its test prints, resulted in isolation of "class" flaws and a previously unobserved "individual" printing flaw. The accumulative presence of these features enabled an association between the anonymous documents and the suspect inkjet printer.

Association of Counterfeit Documents to a Printing Plate by Means of Halftone Dots

(Linton A. Mohammed and George G. Jenkinson)

Several printing plates, proofs, suspect documents and genuine documents were submitted for examination. Comparison of the printing established that the suspect documents were counterfeit. Comparison of the halftone dots to the printing plates, proofs and suspect documents under high magnification (X80) established a similarity in the numbers, shapes, sizes and connectivity of the dots. Using these patterns, it was possible to distinguish between 6 equivalent images on the cyan printing plate and to say which was associated with a specific suspect document. A determination could be made that the printing plates, proofs and suspect documents shared a common source.

Ink Differentiation for the Fiscally Challenged

(Steven G. Drexler and Geoffry Smith)

Being asked to distinguish between two or more inks that may have been used to alter a document is a common problem posed to the Forensic Document Examiner. In today's modern laboratory, sophisticated instruments have been made available, such as the *VSC-4* and *VSC2000*, manufactured by Foster & Freeman, Worcestershire, England, that are specifically designed to aid in the differentiation of inks. However, the considerable expense may make these instruments unavailable to many government and private laboratories. The present study introduces a low cost ink differentiation system, comprised of simple commercially available components, and tests its ability to distinguish between various black inks.



Impression by Traced Forgery

(Robert D. Kullman, Michael Sinke, and Erich Speckin)

In the effort to determine whether it was possible to successfully “forge” indented impressions, 39 individuals were asked to trace entries on a prepared form. An Electrostatic Detection Apparatus (ESDA) was used to develop indented impressions created by the tracings. The developed impressions were then compared to the prepared entries. The research indicated that fully developed ESDA impressions that consist of more than a short single stroke were readily identifiable as the product of original writing or the product of tracing. Additionally, many impressions consisting of short single strokes were also detectable as authentic impressions or traced forgeries. Further, weak ESDA impressions of more than 2 letters or formations were also identifiable as “forged” tracings.

Historical Review: Questioned Documents

(Albert S. Osborn and Albert D. Osborn, with introduction by John Paul Osborn)

This is an abridged version of an article published by Albert S. Osborn and Albert D. Osborn dated January 1941. The article was published just the year before the formal founding of the American Society of Questioned Document Examiners in 1942. Albert S. Osborn was the first president and primary organizer of the ASQDE. Albert D. Osborn served as the third president. This article is being reprinted in tribute to the 60th anniversary of our organization.

Abstracts

Volume 5, Number 2

Editorial: What Good Is a College Degree for an FDE?

(Frederick H. Panhorst)

Habits Observed in Naturally Written Numbers

(Jan Seaman Kelly)

Naturally written numbers tend to be individualized to a particular writer as they depart from the copybook style. Initial and ending strokes, ornamentation, design simplification, overall slant and the interrelationship of component parts in the more complex digits "2," "3," "4," "6," "8," and "9" comprise these basic qualities. This paper will explore the formation of naturally written numbers and the frequency of occurrence of at least one set of numbers connected by the writer in their three-page exemplar. Two hundred participants completed a four-page exemplar consisting of three pages of naturally executed numbers and one page of disguised numbers. For this study, the three pages of naturally written numbers were examined and percentages determined as to frequency of occurrence of habits observed in the three-page exemplars. Out of the 200 participants in this study, 37% connected at least one set of numbers using a connecting stroke. The percentage of writers using the snowman "8" and the crossbar "7" were also assessed. This paper lists the combinations of numbers connected by a connecting stroke and the percentage of usage of specific number formations.

The Greatest Handwriting Mystery of the Eighteenth Century: The Junius Letters

(A Frank Hicks)

Between January 21, 1769, and January 21, 1772, a series of letters were published in a London newspaper. These letters were highly critical of King George and the British government. Although the letters were signed with several different names, they collectively came to be called "The Letters of Junius." The true identity of Junius remained a mystery for decades after the letters' publication. Many people conducted their own investigations in an attempt to identify Junius. Most of these investigations were not directed toward any handwriting comparisons. However, in 1868, a "general Expert in handwriting" named Charles Chabot was hired specifically to conduct handwriting comparisons in this matter. Chabot's reports were published in 1871. His examination techniques and reasoning processes provide ample evidence of his skills in this area and lend significance to his identification of the writer of the Junius letters. His explanations of the manner in which he conducted his comparisons also reveal that the principles used by today's Forensic Document Examiners originated much earlier than generally thought.



Effects of Water Temperature vs. Time in Humidifying Documents for Electrostatic Detection Apparatus Examination

(Bonnie L. Beal)

Forensic Document Examiners (FDE) use different time intervals and water temperatures when humidifying documents before examining them with the Electrostatic Detection Apparatus (ESDA). The purpose of this study was to determine the optimal conditions when humidifying documents for an ESDA examination, for a laboratory that does not utilize a temperature and humidity controlled ESDA room, by using the variables of water temperature and time. The study was conducted using the conditions set forth in the ESDA instruction manual by Foster and Freeman except for changes noted in this paper. The best conditions varied depending on the type of writing instrument and the paper layer examined. Overall, the ideal water temperature and time combination was 55° F for ten minutes.

Author's Introduction

Historical Review: How Much Do People Write Alike?

(John J. Harris)

This article was originally published in the *Journal of Criminal Law, Criminology and Police Science*, Vol. 48, No. 6, Mar/Apr 1958. The reprint is preceded by an introduction by author John Harris which addresses the claim by critics that the article invalidates handwriting identification.

Book Review: "Forensic Examination of Rubber Stamps, A Practical Guide"

(Brian Lindblom)

Abstracts

Volume 6, Number 1

Class Characteristics of Mexican Hand Printing

(Brittany King)

In the forensic examination of handwriting, document examiners must be able to distinguish between class and individual characteristics. If an examiner places too much emphasis on a characteristic that is common to a certain nationality or group of people, an erroneous conclusion may be rendered. With the migration of foreign-born individuals into the United States, it is important for document examiners to be aware of the class characteristics found in foreign handwriting. One of the largest growing cultural groups in the southwestern United States is that of the Mexican people. In this study, the class characteristics of Mexican hand printing are examined. Specific letter formations, which occurred often enough to be considered as class characteristics, are identified. The letter formations, as well as the statistical data are presented in this paper.

A New Check Security Feature: Thermochromic Ink

(Charlotte W. Ware)

One of the newest check security features being utilized today is a logo or mark printed on a check using color-changing ink. This allows anyone to verify the authenticity of a document quickly and easily. By rubbing your finger over the mark, the document can be authenticated immediately, and can be repeated over and over again as the check is passed from person to person. But just how does thermochromic ink work? The chemistry of the ink and use of it both in document security and in other applications are discussed.

Enlargement and Reduction Characteristics of Facsimile Transmission Copies

(Brian S. Lindblom, Dan C. Purdy, and Karina Lange)

A research project was designed to determine the extent of enlargement and reduction of documents transmitted by different facsimile machines. In addition, the scope of the study was expanded to answer the following questions: *Does the transmitting or receiving machine have a greater influence on the enlargement/reduction of faxed documents? Is the degree of enlargement/reduction consistent from one transmission to another? Do significant differences exist in the degree of enlargement/reduction from one page to another in multi-page facsimile transmissions? Is the degree of enlargement/reduction equal along the horizontal and vertical axes?* Receiving machines were found to have a greater influence on the output size of faxed documents relative to the sending machines. Considerable changes in size were observed between originals and faxed copies, between separate pages of multi-page facsimile transmissions and within individual faxed documents. Although extreme differences in size were uncommon, faxed copies ranged from 12% smaller to 2.9% larger than the original template. Document examiners should be aware of these facts when inspecting faxed documents.

Triplet and Sibling Handwriting Study to Determine Degree of Individuality and Natural Variation

(Sandra Ramsey Lines and Frankie E. Franck)

There have been no reports in the literature of handwriting studies that involved the comparisons of writings of triplets or comparisons of writings of multiple-birth siblings with their nonmultiple-birth siblings. The purpose of this small study, therefore, was to determine if the writing of one set of triplets and their nontriplet sibling could be distinguished and, if so, the degree of individuality in each subject's writing. Unlike previous twin/sibling studies, normal or natural variation (inwriter variation) is examined and contrasted with differences or dissimilarities (interwriter variation). The findings support the concept of natural variation in handwriting and two of the axioms of handwriting identification: (1) no two individuals write exactly alike, and (2) no one individual writes the same text exactly the same way twice.

Book Review: *Document Examination on the Computer, A Guide for Forensic Document Examiners*

(F. L. Lee, Jr.)

Abstracts

Volume 6, Number 2

Striation Patterns in New and Used Ballpoint Pens (Jane A. Lewis)

This study examined the incidence and individuality of striations in strokes produced by ballpoint pens. Ink strokes produced by various ballpoint pens were examined microscopically. Striation patterns produced by high-end (> \$10.00) versus low-end pens (< \$10.00) were also considered. Differences in the incidence of such ballpoint pen striations were assessed from samples of new pens versus samples of used pens. Photomicrographs illustrate the types of ballpoint pen striations observed.

The Initial Profiling Trial of a Program to Characterize Forensic Handwriting Examiners' Skill (Bryan Found and Doug Rogers)

This paper reports the results of the first profiling trial of a program that was developed to provide information concerning the skill characteristics of document examiners in expressing authorship opinions on handwritten text and signatures. This information is provided to participants of the profiling trials in the form of a certificate that numerically describes the nature of their skill in terms of correct, error, and conservatism rates. The rationale for the program, given recent criticisms of opinion identification evidence of this type, and some elements of the testing program are described. The performance feedback package is overviewed which provides examiners with the opportunity for corrective action where required. In this trial, 20 government employed document examiners provided opinions on the process of production and authorship of 250 questioned signatures that were a mixture of genuine, disguised, simulated, and auto-simulated signatures. Findings for the group included a very low error rate (0.04%) for authorship opinions, with a high correct rate for genuine signatures, and a high conservatism rate for simulated and auto-simulated signatures. Examiners correctly identified that signatures were simulated in 95% of instances.

Lineup: The Reliability of Examinations Involving Multiple Writers (David L. Parrett and Garry Szabo)

A 1999 United States District Court ruling suggested possible bias in one-on-one questioned to known suspect document examinations. The ruling was, in part, a result of document examination critic Mark Denbeaux's assertion that an examination of the writing of several persons similar to a police "lineup" might produce a different opinion by the examiner. In contrast to the traditional police "lineup" of a few individuals, this study employed the writing of 1,000 "suspects." Four examiners were provided a questioned document consisting of a "London Letter." They were given the task of determining if the questioned author's handwriting was among the 1,000 "London Letters" gathered from different writers. All four examiners, encompassing a wide range of experience, reached definitive correct conclusions.

Identifying Manufacturer and Date of Manufacture of a CD-R and CD-RW (Sandra Ramsey Lines and Jared M. Annes)

A computer disc was suspected as having been produced in the summer of 2002, rather than the dates displayed for the files on the disc that indicated the disc was used (burned) on May 21, 1999. The forensic document examiner was asked to: remove the stick-on label that obscured the information underneath; identify the manufacturer or distributor from the information imprinted on the disc; then make contact with the manufacturer/distributor to determine the dates of manufacture and distribution of this particular disc to prove or disprove the disc was burned in 1999. Research into the manufacture and distribution of a CD-R and CD-RW revealed that it is possible to identify the manufacturer of compact discs by using special software. The label was removed without damage to the disc and the information it contained. Contact was made with the manufacturer and distributor of the CD-R. It was learned that the disc was in existence as the time the information was purportedly burned on it.

Dichroic Filters: Their Use in Questioned Document Examinations (Gerald Richards)

This paper provides a description and history of dichroic filters as they have been adapted and used by the forensic document examiner. In addition, an explanation is provided as to how the filters function in conjunction with the human eye or electronic imaging device. Different types of filters and their sources are fully described.



The Handwriting Testimony in the Trial of Bruno Richard Hauptmann (A. Frank Hicks)

The trial testimony involving the kidnapping and subsequent death of Charles A. Lindbergh, Jr. was explored in some detail. The strategies used by the prosecution and the defense when questioning the document examiner experts were addressed and some of the more notable answers highlighted. Photos of the ransom letters and some court charts have been shown.

Abstracts

Volume 7, Number 1

Reconstituting Gradation Using Multiple Photocopier Splits (James R. Daniels)

A semblance of tonal gradation may be achieved by image summing a series of light and dark first generation photocopies. The relationship between this rendition and that resulting from conventional photography or high-resolution scanning is demonstrated at the proof-of-concept level using a darkroom gray scale.

ESDA Effects in Light of Current Discussions (Gary Licht and Ercole Murano)

Unknown parameters abound in the collection, preservation and interpretation of indented writings. One very useful method for visualizing these indented writings is through the use of electrostatic detection devices (EDD). In this paper, the instrument discussed is the Electrostatic Detection Apparatus (ESDA). The purpose of this work is two-fold. First, to develop an efficient and safe way to collect and develop impression evidence with little to no loss of reasonable and resolvable detail. Second, to provide some theoretical explanations as to the “why” of the results. Research presented here shows the effects of external factors that cause varying amounts of friction with a document, and how these effects are detrimental to the ability of the ESDA to detect handwriting impression. Some information is developed about why impressions may or may not be visualized with the ESDA whether they are visible with oblique lighting or not. A current theory of what makes writing impressions that are suitable for visualization is reviewed in light of empirical data from experiments and field observations in casework. Recent discussions of the effects of environmental factors, for instance gloves, are fit into the framework of the theory.

Modern Approaches to the Forensic Analysis of Inkjet Printing—Physical and Chemical Examinations (Gerald M. LaPorte)

Documents submitted for forensic examination that have been printed by inkjet printers are becoming much more predominant. With the advent of this technology, there has been tremendous popularity amongst criminals to use inkjet printers and copiers to commit a variety of crimes such as counterfeiting, criminal record keeping, and extortion. In some instances, legitimate transactions such as contracts and wills later become the focus of a criminal investigation. This may prompt a suspect(s) to alter entries, generate new documents in an attempt to substantiate his case, or make false claims regarding the questioned document. Forensic document examiners can perform a variety of physical and chemical examinations that may help link multiple documents with each other or a suspect printer(s), ascertain if the document is legitimate with respect to date, or determine the make and model of the suspect machine. This article will provide a comprehensive discussion of modern approaches to the physical and chemical examination of documents produced by inkjet copiers and printers. In addition, some new ideas will be proposed to provide forensic document examiners (FDE) insight into the future of inkjet analyses.

Admissibility Issues in Forensic Document Examination (Thomas W. Vastrick)

The admissibility of forensic document examination has, on occasion, been challenged in courts across the United States. This paper reviews the requirements and guidelines under U.S. Supreme Court decisions of recent years as related to Rule 702 of the Federal Rules of Evidence and compares them to studies, research, methodologies, testing, and publications within the discipline of forensic document examination that relate to these guidelines, and outlines how forensic document examination meets and exceeds each of these guidelines. In addition, this paper reviews statements made by critics in testimony and nonpeer reviewed articles concerning forensic document examination as it relates to admissibility issues. These statements are compared with the raw data on which many of the statements were based. Many of the critics’ conclusions were inaccurate.



A Study on the Influence of Light Social Drinking on Writing by Chinese in Hong Kong (Yau-Sang Patrick Cheng and Yee-Mei Amy Leung)

A study was conducted on the effect of light social drinking on handwriting involving the writing of Chinese, English, Arabic numerals, and some geometric shapes. All of the 151 participants were ethnically Hong Kong Chinese and ranged from occasional drinkers to habitual drinkers of alcoholic beverages. The results of this study confirmed observations made in previous studies of the effects on handwriting due to alcohol consumption. In general, the forensic document examiner can expect to find the effects to include an increase in size of the writing, wider word spacing, and increased pen pressure along with possible writing mistakes. The other aspects of handwriting such as the quality of writing, writing characteristics including writing movements, alignment, and slant would largely be retained. The writing of geometric shapes after light drinking agreed with that of text writing with some exceptions.

Abstracts

Volume 7, Number 2

Examination of Counterfeit Banknotes Printed by All-in-One Color Inkjet Printers (Joyce L. C. Chim, Chi-Keung Li, N. L. Poon, and Sze-Chung Leung)

An increasing number of cases related to counterfeit Hong Kong banknotes produced by all-in-one inkjet color printers have been encountered recently. Unlike those generated by color laser printers or photocopiers, characteristic dot patterns or irregularities are not present on counterfeit banknotes generated by color inkjet printers, thus creating difficulties in the identification of the printer. This paper describes the relationship between the counterfeit banknotes and printers seized in local clandestine factories. The conventional thin layer chromatography (TLC) method was employed to study the ink profiles of the inks present on the counterfeit banknotes and was found to be a useful tool for distinguishing different printer inks.

Thermal Gradient Mechanism of Line Crossing Anomaly (James R. Daniels)

Order-of-strokes tests were conducted to investigate a potentially misleading feature of line crossings in a specific category, namely intersections of moderately embossed handwriting and laser printing, in which rarely encountered crossings of laser printing over pre-existing pen strokes mimic the opposite and more normal order.

Authentication of Travel Documents via the ImageXpert System (Colin Estabrooks, Cathie Gilmour, Helen Park, Robert Vallières, and Christine Warias)

In this study, genuine and counterfeit travel documents were critically measured and analyzed with the aid of the ImageXpert System. A variety of printing processes and security features from both genuine and counterfeit passports were measured using various tools within the software of the ImageXpert System. The data from these measurements was then compared in an effort to discriminate high-quality counterfeits from genuine documents. In addition, any potential links amongst the counterfeits were also noted.

The Significant Contributions of Dr. Philip D. Bouffard to the Examination and Classification of Typewriting (Mary W. Kelly)

In 1987, Dr. Philip Bouffard began his work on developing a personal computer-based classification system for typewriting, which later became known as "TYPE." It was designed for classification of type-style specimens from the Haas Atlases. These atlases were created by Josef Haas beginning in 1972 in Germany. Dr. Bouffard's system makes use of separate classification schemes for each of the major design groups.

The Differentiation of Color Laser Printers (Chi-Keung Li, Wai-Chung Chan, Yau-Sang Cheng, and Sze-Chung Leung)

A survey of color laser printers from different manufacturers (Canon, Epson, Fuji Xerox, Ricoh, Minolta, Hewlett-Packard, and Tektronix) resulted in the observation of dotted motifs of different patterns on the printouts from Canon, Epson, Fuji Xerox, and Ricoh color laser printers. Studies thus far found that the dotted motifs were different on the same model of Canon printers that each bore a different serial number. The data suggests that these distinctive dotted patterns are related to the serial numbers of the machines and could be used for the identification of a particular color laser printer. A feasibility study on the use of Raman spectroscopy for the differentiation of toners of different manufacturers of color laser printers was found to be unhelpful in discriminating printers.



Methods of Forgery in Counterfeit Travel Documents

(P. K. Ng, W. S. Hui, Joyce L. C. Chim, Chi-Keung Li, and N. L. Poon)

With rapid developments in international travel, fraudulent travel documents used by illegal immigrants and criminals are frequently encountered by document examiners in Hong Kong. As the methods of forgery display certain consistent trends for a particular type of forged travel documents, the discovery of evidence of tampering or alteration on these documents is not a random process but is often targeted towards specific aspects of forgery. This article describes some of the target examination of some types of passports encountered in the authors' laboratory, namely, the People's Republic of China (PRC), Hong Kong Special Administrative Region, People's Republic of China (HKSAR PRC), Canadian, Korean, and the Philippines.

Abstracts

Volume 8, Number 1

The Application of Profilometry in the Analysis of the Lines Crossing (Jan De Kinder and Veerle Berx)

A new approach for the problem of lines crossing was developed in this research project: laser profilometry was applied to crossing texts on questioned documents to determine the sequence of writing. Four major parameters influenced the presence of the crossing lines: the pressure exerted during the writing process, the kind of writing material and thus the kind of ink deposits, the type of paper used, and the angle between the crossing texts. In this paper, the writing pressure of both lines, together with the substrate (soft or hard), was controlled and varied through the tests. Homogeneous as well as heterogeneous writing pressures were evaluated. For the majority of the samples, 3-D topography gave conclusive information about the writing order, based on the presence of a complete intersection of 1 of the lines or an oval impression in the direction of the last-applied stroke. This research makes the laser profilometry a promising technique for questioned document examination.

Disguised Signatures: Random or Repetitious? Marie E. Durina

In an effort to determine if people use the same disguise repeatedly, 62 writers at the San Diego Sheriff's Crime Laboratory participated in a study and were asked to provide both a natural and a disguised signature on specimen checks. Approximately 1 month later, they were again asked to provide a disguised signature on another specimen check. In addition to documenting methods of disguise used, this study focused on determining whether people tend to disguise their signatures in the same manner each time. Results showed that approximately 89% of the participants disguised their signatures in the same way on each occasion. It is believed that information from this study will prove useful in cases where forensic document examiners encounter multiple cases involving repeated disguise of an individual's signature.

COMMENTARY: Questioned Documents in Romania (Dr. Jay Levinson)

The Uniqueness of Facsimile Documents Caused by Changes in Character Pixelation (Sze-Wing Ngan, Graeme McCormack, and Michelle Novotny)

The primary objective of this research was to test the hypothesis that every page transmitted individually by a fax machine will be unique due to changes in character pixelation. The secondary objective of the research was to test the hypothesis that the character pixelation changes can be accurately reproduced on a 1st-generation photocopy. The tertiary objective was to test the hypothesis that every page transmitted by the fax broadcast function will bear similar changes in character pixelation due to those documents sharing the same single-scanning process of the sending fax machine.

The test documents were transmitted from 1 fax machine to individual fax machines located locally, interstate, and internationally. These documents were then returned, and microscopic comparisons were made of corresponding characters appearing on the respective documents. The results of this research demonstrate that each page transmitted individually by fax creates a unique pixelation pattern for each character and that this pattern was accurately reproduced on 1st-generation photocopies of these respective test fax pages.

The research demonstrates that changes in character pixelation can assist document examiners to trace the source of a photocopy of a 1st-generation fax document back to the original received facsimile from which that copy(s) was produced.



Examination of 35 mm Color Transparencies (Paul Westwood and Michelle Novotny)

Forensic Document Services (FDS) was engaged by the New South Wales Police to examine 157 35 mm color transparencies (positives) and a 35 mm camera to assist in the investigation of the disappearance of a young girl. The purpose of the examinations was twofold: first, to determine whether 2 or more of the transparencies originally formed part of the same roll of 35 mm film and, second, whether any of these films had been exposed using the suspect camera. The combination of the findings revealed that the transparencies originated from 26 rolls of film and were exposed using at least 2 different cameras, one of which was the camera submitted for examination. The methodology applied in this examination is equally applicable to the examination of negatives.

Determining the Sequence of Original Ink Writing and Toner Printing (Michelle Novotny and Paul Westwood)

Document examiners are frequently called upon to determine the sequence in which intersecting entries were written. This paper arises from research undertaken to determine the sequence of intersecting original ink writings and toner-printed text. One might intuitively expect that writing over toner would not penetrate the toner. Tests were undertaken based on documents produced on a Hewlett Packard LaserJet printer and a combination of 70 different writing instruments. The subject intersections were prepared to test both sequences of ink *before* toner and ink *after* toner. The points of intersection were examined microscopically before and after the removal of the toner. Corresponding intersections for the 2 sequences were compared. It was found that the extent to which the ink penetrated the toner varied between different ink types.

Abstracts

Volume 8, Number 2

The Importance of Line Width Measurements in Discriminating Between Pencil Types (Chris Anderson, Sigurbjorg Gudlaugsdottir, and Julian Leslie)

Various graphical and statistical analyses were undertaken to investigate whether, in a specimen of pencil writing, it was possible to determine if the writing instrument was a mechanical pencil or a wood-cased pencil. A further consideration was whether it was possible to determine the diameter and/or softness of the lead for mechanical pencils. Ten writers provided samples using each pencil type, together with 4 levels of softness. The maximum width for a character was the measurement of interest. It was found that for particular soft leads it was possible to distinguish diameters of mechanical pencil leads. Distinguishing between mechanical and wood pencils depended on the softness and the diameter of lead. Small diameter soft leads in mechanical pencils were easily distinguished from wood pencils. In the remaining cases, differentiation between mechanical and wood-cased pencils was not readily established.

Indentation Examination Enhancement (Jane A. Lewis)

This research was conducted to test whether adding moisture directly to cascade developer beads would improve Electrostatic Detection Apparatus (ESDA) results. The ESDA was used to detect latent indented impressions on 100 sheets of paper containing indentations. Fifty sheets were processed according to the ESDA manual instructions. Fifty sheets were processed with an additional step. The cascade developer beads were misted with a plant mist sprayer before being dispensed on the document. Results showed improved visualized indentations with the misting method of developing electrostatic images with ESDA.

The Significant Contributions of David J. Purtell to the Field of Forensic Document Examination (Maureen Casey Owens)

David J. Purtell was invited to attend his first meeting of the American Society of Questioned Document Examiners in 1959, and was voted into Regular membership in 1961. He was one of the first government document examiners to hold membership in the Society. His document examination career dates from 1947 through 1985, and encompasses a myriad of contributions to the profession of forensic document examination and to the advancement and goals of its professional organizations.

Examination of Gel Pen Ink by Microspectrometry (Paul Martin and Albert H. Lyter, III)

The examination of writing inks has been an integral part of questioned document examination since its inception. The types of inks and writing instruments of concern have progressed from pencil and nib pen to ballpoint and porous-point pens. The most recent development in both ink and writing instruments has been the gel-ink pen. This instrument is a marriage of the ball pen with polymeric gel ink containing both dyes and pigments as colorant and water-based gel. This paper looks at the feasibility of using a Craic Technologies Questioned Document System II (QDS II) microspectrometer as an analysis tool for the differentiation of gel-pen inks. Using several sample preparation methodologies over the full spectral range from ultraviolet to infrared, 7 different black gel inks were examined with the QDS II. Additionally, 2 blue gel inks (with common manufacture as several of the black inks) were also examined. Results of these examinations indicate the ability to differentiate, to varying degrees, the black gel inks and consistency between those inks of common manufacture (blue and black). The preferred sample preparation methodology was also identified and elucidated.



**COMMENTARY: Why Forensic Document Examiners' Training Must Be for a Minimum of 24 Months
(Joseph L. Parker)**

**Examination of Gel Pen Inks Using Physical and Thin Layer Chromatographic Examination
(O. P. Jasuja, A. K. Singla, M. K. Mand, and Albert H. Lyter, III)**

The use of thin layer chromatography (TLC) in the examination of writing materials is well documented and a proven technique. As technology continues to develop new and better methods of manufacture, those methods will permeate society and give rise to different products. This has occurred within the field of writing materials, as both instruments and inks have changed over time from nib pens to ball pens and from natural inks of iron to inks of pigment suspensions in water-based polymer gels. This most recent development, gel pens, combines ball pens with pigmented polymer gel ink. The gel pen presents a challenge to the forensic examiner, which is addressed initially with this study, including both traditional physical examinations, chemical spot tests, and TLC. A total of 98 different samples of gel pens were examined and yielded examination results that provided for discrete discrimination of over 35% of the gel pens.

**BOOK REVIEW: Review of *Laws of Men and Laws of Nature – The History of Scientific Expert Testimony in England and America*
(Linton A. Mohammed)**

**Linking Inkjet Printing to a Common Digital Source Document
Charles E. H. Berger, Jan A. de Koeijer, Wendy Glas, and Henk T. Madhuizen**

Minimal differences in a digital source document will drastically change the error diffusion dot pattern of an inkjet print. This study explains and demonstrates this effect and shows how this particular property of the error diffusion screening method can be used to link inkjet-printed documents to a common digital source. The results of the study were applied in a case.

**UV Scanner
(Raymond Orta M.)**

Examination of documents under ultraviolet radiation has become an important aid in determining possible modifications, substitutions, and/or alterations to documents. Forensic analysis of documents often involves creating illustrations of findings. It has not been uncommon to use ultraviolet film for this purpose. Ultraviolet film requires careful handling, special illumination, and occasional trial and error to obtain a good result. In addition, use of ultraviolet film is time consuming and expensive. In late 2000, experiments were undertaken to change a flatbed scanner into an ultraviolet (UV) scanner. The light tubes in several flatbed scanners were replaced, first with a short-range UV tube, then a long-range UV tube. Ultimately, excellent focused images resulted using 1 particular scanner. The UV scanner operates conventionally, although it acts on the radiation, intensity, and frequency band of the tube installed.

Abstracts

Volume 9, Number 1

A Study on the Levels of Difficulty in the Simulation of Individual Characteristics in a Signature (Gek-Kwee Lee, Bei-Sing Yap, Chiew-Yung Yang, Lee-Tiang Lee, Sock-Kim Tan, and Koon-Puay Tan)

This study looks at the levels of difficulty in simulating a signature with respect to 12 selected individual characteristics in a model signature. The objective was to find out which of these features in the signature were relatively easy or difficult to simulate and to compare the results with those expected based on the team's knowledge and experience in forensic handwriting and signature examination. Sixty-two volunteers took part in the study. The results of the analysis show that the experimental data is generally in agreement with the expected relative levels of difficulty of the characteristics studied. This study provides good evidence that the principles and knowledge applied in forensic handwriting and signature examination are sound and reliable and that characteristics in a person's signature are individualized.

Limited Populations – Are They Feasible for Handwriting Examinations? (Chris Anderson, BSc and Julian Leslie, PhD)

The term *limited population* refers to an examination involving a small number of potential writers who could have written a questioned document containing a very limited number of characters. An investigation was undertaken to ascertain the impact a limited population of writers would have on identifying the actual writer. Two simple statistical models were used in this study. Unsurprisingly, the chance of identifying the writer reduces as the number of potential writers increases. However, this reduction became quite marked for certain values of quantities used in the models. The quantities of relevance were the number of key distinguishing features in the writing and 2 probabilities—1 associated with incorrectly deciding that a character was not written by the writer of the questioned document and the other associated with correctly identifying a character as not written by a person who did not write the questioned document.

Capillary Electrophoresis of Ballpoint Pen Inks (James M Egan, Jason D Brewer, Kristin A Hagan, and Cheryl L Strelko)

Two capillary electrophoretic (CE) methods have been designed to differentiate and identify organic and inorganic dyes present in black and blue ballpoint pen inks. CE was chosen because the technique provides chemical information that can provide better discrimination between ink formulations than thin-layer chromatography (TLC) when comparing ink samples during document analysis. One CE buffer was designed to separate and analyze 10 blue ballpoint pen ink formulations. An alternative buffer was designed to separate and analyze 15 black ballpoint pen inks and 2 different inkjet cartridge products from the same manufacturer. The capillary detection method using a photo-diode array (PDA) to acquire absorbance data (190-600 nm) provides λ_{\max} and characteristic UV-Vis spectra for analytes. Simultaneous spectral data collection avoids the necessity for densitometry measurements. Mobility values (μ_{ep}) calculated from a migration time replace hand-measured TLC R_f values. The sample electropherograms are reproducible with 2 $\mu\text{g/mL}$ concentration limits of detection, which is superior when compared to TLC separations. Specific chemical identification can be determined based on spectral and mobility value match to reference dye standards. All inks were differentiated from one another in the respective category (blue, black, or inkjet formulation). When possible, chemical compounds were identified in a particular ink to aid characterization. CE offers additional advantages over TLC, including lower reagent consumption, smaller sample requirements, lower detection limits, quantitative analysis, method automation, direct reference comparison, electronic data storage, and searchable spectral libraries. Other complimentary techniques (TLC, positive- and negative-ion mode electrospray-ionization mass spectrometry) can be performed because little sample (20 nL) is consumed for CE analysis. The same CE buffers formulated for ballpoint pen inks have been applied to color inkjet printer formulations, food dyes, gel pen inks, and textile dyes.

Using TLC and GC-MS to Determine Whether Inks Came from the Same Manufacturing Batch **(Valery N Aginsky)**



Gas chromatography-mass spectrometry (GC-MS), being a well proven analytical method of determining the qualitative composition of multi-component systems, is effective for the analysis of inks, most of which are complex mixtures of chemical compounds. A combination of thin-layer chromatography (TLC), which analyzes ink colored components, and GC-MS, which analyzes ink noncolored components, demonstrates high discriminating power with regard to writing inks that can be distinguished neither by nondestructive techniques nor by TLC. Case examples are considered in which coupling of TLC and GC-MS allowed one to discriminate between ink indistinguishable by TLC and to determine that the inks on questioned documents came from the same manufacturing batch.

Micro-Raman Spectroscopy of Color Inkjet Printed Documents **(Williams David Mazzella, MS; Adrien Mathieu, MS; and Patrick Buzzini, MS)**

Inkjet printed documents produced by 22 different brands and models of color inkjet printers available on the Swiss market were analyzed by micro-Raman spectroscopy using a near infrared (NIR) excitation wavelength of 785 nm. The magenta components were discriminated into 11 groups, but the cyan inks could not be further distinguished. The yellow inks did not exhibit significant Raman scattering; however, the cyan inks could not be further distinguished. The yellow inks did not exhibit significant Raman scattering, but the signals may have been concealed due to strong interference from the paper background.

Abstracts

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Examination of Newspapers

John D. Makris, Spiridon A. Krezias, and Vasiliki T. Athanasopoulou¹

This paper addresses the significance of applying a combination of tests involving paper, ink, writing offsets (image transfers), folds, printing processes, and defects to determine whether there were alterations within 3 newspapers. A brief overview of the examination methods is provided in a step-by-step analysis of this unusual case involving disputed inserts of a daily local newspaper. The examination revealed conclusively that the initially incorporated inserts had been replaced with the disputed ones.

Thinking Outside the Box

(Linton A. Mohammed and Gerald B. Richards)

To prevent the possibility of any bias developing, many forensic document examiners are taught that they should get as little background information on a case as possible. In some cases, the lack of background information can be both misleading and detrimental to discovering the truth. This paper describes a case history in which background information on a medical record was necessary to resolve the case. The information was obtained after all examinations had been completed. However, if known beforehand, the information may have saved both valuable time and resources. Giving an opinion is easy; finding the truth may be much more difficult.

Application of Hyperspectral Imaging to Forensic Document Examination Problems

(R. Brent Ostrum)

Imaging spectroscopy is a powerful tool used extensively in many different remote-sensing applications. The parallel to applications in forensic document examination is exact, but the potential of this method has not been fully explored. A customized imaging system based on electronically tunable filters was used to generate hyperspectral image data from ink samples known to be difficult to differentiate using other spectral methods. The potential of hyperspectral imaging (HSI) as a tool for forensic document problems was evaluated specifically for ink differentiations and the decipherment of obliterations on questioned documents. In this study, various HSI methods were used to show differences between test inks. The most effective results were seen in plots of spectra response, while other methods (such as pseudo-color images of select bands) proved to be ineffective. Select results were also compared to those obtained using a VSC-2000 and found to be as good or better. The basis for a fully automated HSI analysis system was developed.

Another Look at Handwriting Movement

(R. Brent Ostrum and Tobin A. Tanaka)

Forensic document examiners usually observe and assess line quality in the written stroke without direct knowledge of the kinematics of the writing instrument used to produce it. Features in handwriting relating to line quality such as speed or pen pressure variation have been described since the days of Osborn. Qualitative assessment of such features by document examiners is routine and made according to well documented principles. In this pilot study, a digitizing tablet with an inking pen was used to measure the movement of a writing instrument as a time series of data points. Handwriting from 15 subjects was obtained using a limited passage of cursive text, basic handwriting movements, and hand-printed text. Traditional examiner evaluation of select features was compared to dynamically measured data produced by the writing tablet. The study suggests that this type of handwriting measurement system can be used to test various theoretical aspects relating to both handwriting movement itself and to the examination of that handwriting by document examiners. More specifically, the study demonstrates a new and effective method for the validation of examiners' abilities regarding the "subjective" assessment of dynamic writing characteristics from a static written record.

A Study of Attempted Simulated Signatures by Teenage Writers
(Ellen Mulcrone Schuetzner)



The authors Harrison, Hilton, Huber and Headrick, and Osborn defined characteristics of simulation. Based on the written works of these authors, a study was conducted using 19 categories of reported characteristics of simulation. Attempted simulated signatures were obtained from 106 teenage writer participants and the results examined for 1 or more of the 19 simulation characteristics. This study supports the recorded works by these noted authors pertaining to characteristics of simulation.

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A Study on the Influence of Wearing a Glove on Handwriting by Chinese in Hong Kong (Yau-Sang Patrick Cheng)

A person's writing might be affected by a number of factors. These factors could be internal or external. This paper investigates the effects of wearing a glove when writing English cursive and block letters, Arabic numerals, Chinese, and when drawing geometric figures. Three types of gloves were chosen for the study: disposable glove, thin cotton glove, and thick cotton glove. Writing characteristics, line quality, and fluency of writing were not affected to any appreciable extent by the wearing of the 3 types of gloves. However, the influence of glove wearing on handwriting did affect writing pressure, size of words, word spacing, line spacing, and margin relationship. In addition, occasional pen slips and awkward lettering and strokes were noted in some handwriting samples. The results serve as a reference for document examiners when examining handwriting of a person writing or suspected of writing while wearing a glove(s).

Forensic Image Analysis of Laser-Printed Documents (Williams D. Mazzella, MS and Raymond Marquis, MS)

A preliminary study was undertaken to determine if objective measurements, using a proprietary image analysis system, may be routinely applied for the analysis of electrophotographic-printed documents, in particular laser-printed documents. Text and dot-quality objective measurements were studied to differentiate printed outputs. This paper highlights the complementarity of forensic image analysis to classical methods employed for the analysis of laser-printed documents. Some practical tests were prepared and discussed. Discriminant analysis correctly classified the samples from the tests, thus demonstrating that forensic imaging analysis is realistically applicable in closed-set cases (where the number of potential laser printers can be clearly defined) and in page-substitution cases.

Design and Security Features of the Euro Carl R. McClary

The largest monetary changeover in Europe's history occurred on January 1, 2002, when 12 European Union (EU) countries converted their national currencies to a common monetary policy. With this conversion, sophisticated design and security features were implemented, together with counterfeit tracking. Although counterfeits rose remarkably within the first few years, they are now considered stable. Since 2002, 13 out of the 27 EU countries have withdrawn their own notes and coinage from circulation and replaced them with the euro. The changes were not without controversy. However, the result is a more unified Europe and better integration in world financial markets. This paper will describe the latest security features such as foil, printing, watermarks, and holograms found in the new currency. Familiarity with the design and security features of the euro will assist the document examiner in the examination of counterfeit currency or in providing basic information for investigative purposes.

Invisible Ink: A Refresher for Document Examiners James L. Streeter, Greg P. Kettering, and Kenneth B. Zercie

With recent publicity concerning imprisoned gang members using invisible ink to communicate instructions for murdering rival gang members, it is anticipated that other inmates will "copy-cat" this "secret communication" technique. This paper reviews the history of invisible ink, discusses materials most commonly used in correctional facilities to produce invisible inks, and explains the various methods for identifying and developing the writing produced by these substances.

Voltage and Indentation Development Tobin A. Tanaka

Electrostatic detection devices (EDDs) utilize charging to visualize indentations on documents. In this study, a voltage probe was used to measure the characteristics of the voltage at the surface of the film covering the document to better understand this electrostatic phenomenon. The ultimate objective of this research was to enable document examiners to obtain better development of indentations. This initial work demonstrated that such measurements are useful for controlling the extent of charging the film.

Abstracts

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Original Research Paper: Influence of Writing Posture on the Dimensions of Signatures

Céline Equey, MS; Raymond Marquis, MS; and Williams D. Mazzella, MS

In order to study the influence of writing posture on the dimensions of signatures, the authors asked 21 volunteers to sign their names in 4 different writing positions. Such items as receipts, checks, or short notes are sometimes written or signed in unusual writing positions, which some claim may influence the dimensions or proportions of the writing. The measured parameters (length, height, proportions) that are modified when writing under unusual conditions, as well as the range of these modifications, proved to be variable from 1 writer to another. While the average variation for the writers in this study was low, great variations were observed in some cases. Furthermore, no correlation could be established between the kind of variation observed and the graphical appearance of the signatures. Forensic Image Analysis of Laser-Printed Documents

Case Report: Can You Have the Perfect Training Case?

Janette Dove Guscott

This case involves a bomb threat letter listing the Aurora Police Department in Colorado as its intended target. When responding to the return address on the letter, officers retrieved multiple harassment letters with pornographic material and were informed by the individuals at this address of stalking by a suspicious neighbor. The recipients of these harassing letters offered that there were additional victims in the neighborhood. Examination of the initial bomb threat document using the elements of document examination tied the multiple cases in the neighborhood together. This case involved handwriting identification, indented writing, observations of an ink defect in the printing process of a notepad and a crease in another notebook, and a physical match to prove the connection between the multiple cases. The results of these examinations were instrumental in obtaining a conviction.

Microsoft Access in the Questioned Document Laboratory

Linda J. Hart and Lamar Miller

Microsoft Access is a readily available database program suited to assist questioned document examiners with extended writing cases, especially those involving voluminous exhibits. Questioned and known samples are scanned into a Microsoft Access database table. Access sorts the handwriting characters into charts and organizes the groups into the questioned and known samples. Once the database table is populated, an infinite variety of comparison charts are easily prepared. Charts may be used for the examination process and as demonstrative evidence. As an example, Microsoft Access is capable of easily preparing a comparison chart of all the words which end with "ing," all the words which begin with a "B," and all the words containing "th." Any characters or combinations of characters are easily sorted and printed in a comparison chart. In addition to organizing voluminous exhibits, the program's flexibility allows the examiner to remake charts on the eve of trial in cases in which some of the exhibits cannot be used in trial.

Neurosciences Applied to Handwriting Examination

Raymond Orta M. and Magdalena Ezcurra G.

Some difficult cases for forensic document examiners can be related to brain illnesses that affect handwriting. As a brain-governed function, handwriting has been studied by medical science for many years. Those studies could be crucial to guiding the expert in evaluating causes of variability in handwriting. A. R. Luria was a neuropsychologist at the University of Moscow who studied consequences of different injuries to the human brain. Part of Luria's work focused on the handwriting of patients with brain wounds. Our objective was to review some of Luria's most relevant findings compiled in the book, *The Working Brain, An Introduction to Neuropsychology*. Some neuroscience findings from other authors who studied handwriting from a medical point of view are also included.

The Effect of Water Soaking on Ballpoint Pen Writings

Atul K. Singla, Ph.D.; O. P. Jasuja, Ph.D.; and Sarbjit Kaur

A forensic document examiner may be confronted with the problem of restoration and examination of water-soaked documents. Various methods have been recommended by different individuals and are being applied to restore water-soaked documents. The present study has been conducted to determine the effect of water soaking on ballpoint pen writings on different types of paper; at different intervals; and in neutral, acidic, and alkaline aqueous media.

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A Comparison of the Identifying Features in Original Signatures and Electronically Scanned Signatures

Nazia Mehrban and Ian J. Turner

Electronically scanned signatures are increasingly being used as a form of personal identification on documents such as driving licences and passports. A comparison of identifying features in 150 handwritten signatures and electronically scanned versions showed that there was a statistically significant number of differences between the 2 groups ($P > 0.01$). The pen type used to create the original signature—a ballpoint, a roller ball, or a fountain pen—was also shown to affect the number of differences observed. Electronically scanned ballpoint signatures showed the least number of differences, and the electronically scanned roller ball showed the most. Paired analysis using the Pearson χ^2 test between the groups of pens shows that they are statistically different from each other ($P > 0.01$). The types of differences observed between the signatures are categorised and vary among the pen types. The variation appears to be related to the composition of the ink within the pens.

With electronic signatures being used commonly as record of identity in databases and on security documents, the forensic document examiner may frequently be required to make examinations of their authenticity or use them as specimen samples. However, the number of observed differences and the effects of a trivial matter, such as the pen used to create the signature, will make that difficult.

Frequency of Signature Styles in San Diego County

Linton Mohammed, MFS; Bryan Found, PhD; and Doug Rogers, PhD

Signatures may be classified into 3 basic structural types: text-based (each allograph can be read clearly), mixed (at least 2 allographs are legible), and stylized (1 or no allograph is legible). The relative frequency of these signature types in the San Diego (USA) population was determined by sampling 1,500 signatures from Juror Summons forms. Of interest to this study were the relationships between type of signature, gender, and ethnicity. This survey disclosed that females more commonly wrote text-based signatures than mixed or stylized types, whereas males more commonly wrote in a mixed or stylized form than in a text-based form. The difference between the genders with respect to the extent of signature stylisation was highly significant (Chi-square = 138.1, $p < 0.0005$). No remarkable differences were found between the frequencies of the 3 signature types in the Hispanic versus the non-Hispanic populations of signers. When the signature types within each of the ethnic groups were compared according to gender, no differences were found between the Hispanic and non-Hispanic males, and only a small (questionable) difference was found between the Hispanic and non-Hispanic female writers.

The Next Wave from the Critics

Bonnie L. Beal

The defense hired Professor Denbeaux to challenge the handwriting analysis for a case going to trial. Before the hearing, Professor Denbeaux provided to the court the results of a “test” he had conducted utilizing the Collaborative Testing Services, Inc. 06-524 proficiency examination. This article will examine this “test” and review its results. In his attempt to discredit the proficiency of forensic document examiners, Denbeaux instead corroborated Dr. Kam’s research.

Left-hand Writing vs. Right-hand Writing

Marianne Conrad

Determining whether a questioned text was written by a right- or left-hand writer can provide useful investigative information. Especially early in an investigation, such information can be a useful tool for rapid screening and narrowing the pool of potential suspects. In this study the writings of 30 left-hand and 30 right-hand writers were analyzed in order to find out if there are diagnostic characteristics upon which the document examiner can rely to establish the handedness of the writer. Direction of certain horizontal strokes and, to a lesser extent, the direction in which circular structures were formed were found to be useful indicators.

A Method of Statistical Evaluation of Handwriting Characteristics Developed in Russia

Tatiana Shlafer



Document experts providing the examination of handwriting evaluate the individual characteristics according to their own experience. Deciding which characteristics are more significant presents difficulty to the examiners with limited experience.

A methodology developed in Russia is intended to assist document examiners in the stage of evaluation of similarities and differences in the handwriting. It employs tables of statistical frequency of individual characteristics derived from examination of representative handwriting samples in Russian. Although this method of evaluation of individual characteristics in the handwriting cannot substitute for personal experience of the document examiner, the values assigned to characteristics based on statistical probability of their occurrence help the examiner to evaluate significance of these characteristics. Moreover, it helps to visually illustrate the process of identification and justify the conclusion in courts.

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Dual Mode Polarizing Pellicle

James R. Daniels

This article describes techniques for using an angled glass pellicle to merge the path of light reflected from a sample with the line of view, permitting glare-angle lighting/observation view normal to the surface. Among other applications, reflective properties of ballpoint and some other writing inks, observed under such conditions, may permit determination of stroke sequence at intersections with other media.

Ranking Handwriting Attributes in the Signatures of One Person: A Survey of Forensic Document Examiners

Martha A. Blake

A survey was designed to capture how forensic document examiners evaluate a set of signatures by 1 person and rank the significance of various handwriting aspects in terms of individualizing quality. Examiners were asked to rank the individualizing quality of a total of 40 handwriting attributes chosen by the author. Sixteen examiners completed the survey. The rankings were compiled and showed moderate to excellent consensus in the ranking of 92% (37) of the attributes and a lack of consensus in the ranking of only 8% (3) of the attributes.

Awareness of the Potential of the EDD Serving as a Source for Transfer of DNA

Diane K. Tolliver and Carl A. Sobieralski

Electrostatic Detection Devices (EDD) have the potential to collect and transfer DNA¹ during processing. "Touch DNA" can now be detected and interpreted under current DNA processes at the Indiana State Police Laboratory. Analysis is by capillary electrophoresis with the PP16 kit² (Promega PowerPlex 16 kit). The EDD bed and humidification chamber were examined for the presence of DNA sources from shed cells. This research examined whether or not EDD processing of documents may be a source of cross-contamination. The 2008 American Society of Questioned Document Examiners (ASQDE) conference theme, "Reasoning with Technology: A Cognitive Approach to Casework," was applied in this research in examining whether or not the forensic document examiner needs to heighten his/her sense of awareness of possible DNA cross-contamination issues when examining documents using the EDD.

Is Atomic Force Microscope a Suitable Tool for Studying Crossing Lines?

Magdalena Ezcurra

This work is a preliminary inquiry into the usefulness of atomic force microscope (AFM) to determine the sequence of crossing lines. Intersecting lines were prepared using different types of pens and printers and studied with AFM to discover whether any diagnostic feature could be found that would reliably indicate which line lay on top. The effect of the age of the ink/printer lines was also studied. Specimens were created with elapsed times between the applications of the 1st line and the 2nd line in seconds, days, weeks, and months in order to study whether the period of time elapsed between the entries, with possible hardening of resin components of certain inks, affected observations.

Abstracts

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Electrostatic Detection Apparatus Enhancement Using Astronomical Image Stacking and Processing Software

A. B. Giles and Audrey Giles

To overcome the practical challenges of imaging very distant, dim, and moving astronomical objects, astronomers have well developed techniques for “tracking and stacking” multiple images of the same object to increase the signal-to-noise ratio of the final image. We have successfully applied the same techniques to multiple electronic detection device (EDD) lifts off the same document to enhance impressions too weak to be read from a single film.

Does My Output Change with Age?

Candice Moussa and Michelle Novotny

Forensic Document Services Pty Ltd., P.O. Box 167, Manly NSW 1655, Australia

Document examiners are often asked to determine whether multiple documents or pages of the same document were produced on the same printer or on different printers. There are several aspects of the document that can be examined in that regard. Documents produced on different laser printers can exhibit differences in the microscopic appearance of the surface of the toner printing, while documents produced on the same laser printer at the same time do not exhibit such differences. This study assesses whether there are any appreciable differences in the microscopic appearance of the surface of the toner printing produced using the same laser facsimile machine over a period of approximately 5 years. No appreciable differences were observed.

Indentations Produced by the Document Feeder Mechanisms of Two Black and White Photocopiers

Larry A. Olson

Forensic Document Analyst, IRS National Forensic Laboratory, 29 North Wacker Drive, Chicago, Illinois 60606

Recent casework revealed that indentations found on a questioned document could be associated with a photocopier's document feeder. This research was undertaken to analyze indentations produced on original documents by the document feeders of 2 black-and-white photocopiers. The copiers, located at the IRS National Forensic Laboratory, were of the same make and model. The goals were to determine what indentations occurred in both single- and double-sided copy modes and whether they exhibited any class, or even individual, characteristics.

Examination of a Collection of Arabic Signatures

Ahmed Al Haddad¹, Peter C. White², and Michael D. Cole³

Arabic is the national language of the 22 Arab States, where it is spoken and written by about 300 million people. Forensic document examiners are often required to examine Arabic signatures, but without the help of any reference library of signatures. This study generated a unique collection of signatures and multiple replicates on various occasions from 188 participants (128 male and 60 female). From this collection, 10 features common to all of the signatures were identified and used to examine the variation between signatures and generate quantitative data. The features (variables) selected included 3 measurable variables (i.e., height, length, height/length [H/L] ratio) and 7 features which could be classified according to a code (i.e., number of strokes, number of dots, direction of ending stroke, legibility of signatures, slant, starting position, and ending position).

Using frequency plots generated from 10 signatures produced on 1 occasion by all of the 188 participants, the distribution of data for each feature could be observed. These results indicated that only 15% of the applicants produced a legible signature, and legibility was shown to have a considerable influence on features such as the number of dots, number of strokes, slant, and ending and starting positions. Some unusual frequency distributions can be observed with several features (e.g., the number of dots, number of strokes and the H/L ratio), thus highlighting the uniqueness of some signatures. This form of visualisation also illustrated some unexpected results. For example, more participants produced right- as opposed to the normally expected left-slanted signatures, and a larger number of females were identified as using more strokes than males.

These frequency plots also confirmed that all the classified features and, to a lesser extent, the measurable variables were not normally distributed. Hence, a Mann-Whitney statistical test was used to determine if, for any feature, there were any significant differences between signatures produced by the male and female participants. Significant differences in data for 5 of the features can be identified; namely, number of strokes, number of dots, height, length, and H/L ratio. With the exception of the H/L ratio, a replicated study using a 2nd set of signatures produced by all the participants on another occasion gave virtually identical Mann-Whitney results, thus indicating the high degree of consistency of some of the selected features.

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Relative Difficulty of Freehand Simulation of Four Proportional Elements in Arabic Signatures

Abdulaziz Al-Musa Alkahtani and Andrew W. G. Platt

This article compares the success with which 901 Arabic writers were able to simulate 4 proportional elements—size, slant, baseline, and spacing—in 2 Arabic signatures. Significant differences in ease of simulation were found among all 4 elements: slant was significantly more successfully simulated than the other 3; baseline was significantly more successfully simulated than spacing or size; and spacing was significantly more successfully simulated than size. The order of ease of simulation was found to be slant > baseline > spacing > size. This similarity between Arabic and Roman script data raises the possibility that slant and baseline, and possibly all 4 elements, might show similar relative rankings in other cursive scripts.

The Determination of Authorship from a Homogenous Group of Writers

Marie E. Durina¹ and Michael P. Caligiuri, Ph.D.²

Forensic document examiners may encounter challenges when examining specimens from homogeneous writing populations and may need to identify potential sources of errors when rendering conclusions of authorship on such writings. A research project was conducted in which samples of writing were obtained from 52 adult writers who grew up in the same neighborhood, were taught the same copybook style, at the same Catholic elementary school, by the same teachers, approximately 4 decades ago. The specimen writings were subsequently examined and compared by 49 forensic document examiners throughout the world. The examiners rendered conclusions of authorship on the writings and submitted their conclusions for evaluation of accuracy. The results of the study offered evidence to support that there is a high degree of inter-writer variation among writers, even in populations where the driving forces for variation were low; and among these homogeneous writing populations, forensic document examiners were able to extract features from the writing samples that enable them to attribute authorship. The study examined effects of certain factors such as examiner experience, geographic location of examiner, and length of the questioned documents and how these factors affected accuracy. The research addressed criticisms that earlier studies on the individuality of handwriting did not include populations from homogeneous writing communities and relied on computer analysis of handwriting rather than on human examiners.

Analysis of Bic Cristal Medium Ballpoint Pen Inks

Magdalena Ezcurra G.^{1,3}, Itxaso Velasco¹, Juan M. G. Góngora¹, M. Itxaso Maguregui², and Rosa M. Alonso¹

This work studies the ink composition of 26 BIC Cristal Medium ballpoint pens, 13 blue and 13 black, purchased from various countries around the world in 2008. The volatile components of these inks were studied by gas chromatography/mass spectrometry (GC/MS) preceded by a liquid-solid extraction, with the use of retention time locking (RTL) for the 1st time in the forensic field. The RTL tool assures reproducible retention times, and the realignment of the chromatograms assures rescaling of the time axis of the chromatogram. In order to determine the qualitative composition of dyes present in each ink, thin-layer chromatography (TLC) was used, followed by the identification of those colorants by liquid chromatography tandem mass spectrometry (LC/MS-MS). The study revealed that at least 2 different blue-ink formulations were used around the world in this period of time but that the formulation of the black inks was identical for all the studied pens. The differences found in the blue-ink formulations regard not only volatile components but also dyes. The great differences found in the concentration of the volatile component phenoxyethanol (PE) present in the 2 blue-ink formulations lead to important differences in the natural aging process of these 2 blue formulations as measured by the loss of the amount of PE against the time. The amount of PE varied depending on the BIC ink formulation between 221.9 µg and 84.7 µg per lineal centimeter of ink stroke 1 day after the ink was deposited on the paper.

Influence of Age, Gender and Handedness in Signature Imitation

James L. Hayes

This article studies the influence of age, gender, and handedness on the ability of student volunteers to simulate signatures. The students were enrolled in an introductory course in Hospitality, Tourism, and Event Management at the Metropolitan State College of Denver. The majority learned to write during the 1980s. The volunteers were provided genuine signatures by older writers who learned to write using the Palmer System. The simulations were done in 2 sessions, the 1st with no instructions on how to imitate a signature. A week later the same students were asked to repeat the exercise, but this time with some instructions in how to copy a signature. The students were given an incentive of earning extra points on their grade for good efforts.

The students' forgeries were then evaluated by a forensic document examiner and graded as to quality. In general, the students created very poor forgeries. The females performed slightly better than the males, particularly after instruction, but even those efforts were not very good.

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Decipherment of Counterfeit Traveler's Checks

Mohammed Aloyoni, Jubran Gushaish, and Yaser Zahrani

Traveler's checks are popular among visitors to Saudi Arabia during pilgrimage (Hajj) time because they are more secure than cash and easy to exchange with local money at local banks. This paper reveals the decipherment of 3 groups of fraudulent traveler's checks that were caught in local banks during Hajj.

Evaluation of Loss of Phenoxyethanol from a Ballpoint Pen Ink over Time by GC-MS Depending on the Location of the Signature on the Document

Magdalena Ezcurra G., Juan M. G. Góngora, Itxaso Maguregui, and Rosa Alonso

Quantification of the loss of phenoxyethanol (PE) once an ink is deposited on the paper is 1 of the methods currently used to determine the relative ages of inks on paper. This work reports an in-depth study on differences in the aging curves, based on the loss of PE, between an ink placed on the 1st page or an ink placed on an internal page of the document. A possible cross-contamination in the values of PE has been also studied, taking into account the amount of PE absorbed and retained by the paper fibres in the pages preceding the page on which the signature is placed. Gas chromatography-mass spectrometry has been used to evaluate the PE.

Using Adobe Photomerge™ for Demonstrative Evidence

Linton A. Mohammed MFS, R. Brent Ostrum, BA Hons

Demonstrative evidence is of utmost importance to forensic document examiners. This paper describes the use of Adobe Photomerge™ as a means of producing large charts from a combination of smaller images. The paper gives a step-by-step description, including caveats, and gives a case example where the technique was used in court.

Fracture Match: A Validation Study of Paper Tears, Part 1

Todd W. Welch, Charles R. Bacon PhD, Mary K. Bacon MS, Sarah A. Bohn

Forensic document examiners are frequently asked to analyze evidence that requires the identification of a torn document by reconstruction. The reconstruction and identification of a rip or tear is also known as a fracture match. Fracture match examinations have important forensic applications in that they may establish a relationship between 1) the suspect and the crime scene, 2) the victim and the crime scene, or 3) the suspect and victim. Be it a ransom note torn from a pad of paper, pieces of a gum wrapper containing drugs, or a spent paper match, these products are often forwarded to the forensic document examiner, who endeavors to determine if the separated items are associated.

In this study, the authors examined single sheets of paper torn under controlled conditions to investigate the uniqueness of their torn edges. The results of the study showed that the fractured edges of single sheets of paper torn under controlled conditions were unique. A 4-point measurement methodology, used to determine the tear profile, was validated statistically.

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The Ability of Forensic Handwriting Examiners to Judge the Quality of Signature Simulations in an Unfamiliar Writing System

Abdulaziz Al-Musa Alkahtani, M.Sc., Ph.D., M.F.S. So.

This article addresses the question of whether forensic handwriting examiners (FHEs) can successfully apply forgery detection analysis to recognize forgeries in foreign signatures with which they are not familiar. Two FHEs who were fluent speakers and writers of Arabic and 2 who were unfamiliar with the Arabic language and script analyzed 100 freehand simulations of 2 Arabic signatures. They gave separate ranks to the accuracy with which each of elements of line quality, form, and proportion were simulated by each simulator. No significant differences were found between the assessments of the 2 teams of FHEs for each element. More research on other scripts, languages, and elements would be desirable to generalize the results.

Quantitative Hyperspectral Imaging Technique for Measuring Material Degradation Effects and Analyzing TLC Plate Traces

M. E. Klein¹, B. J. Aalderink¹, C. E. H. Berger², K. Herlaar², and J. A. de Koeijer²

In forensic document analysis, multi-spectral reflectance and luminescence imaging techniques are routinely used for distinguishing inks and for enhancing the legibility of faint or invisible writing. The transition from conventional, qualitative spectral imaging to quantitative hyperspectral imaging (QHSI) made possible by the SENTINEL instrument facilitates and enhances the applicability of the technique to less common tasks. Several simple demonstration experiments were carried out to illustrate how the QHSI technique can be used in 2 application areas, the study of degradation effects in materials and the analysis of thin layer chromatography (TLC) plates. As examples for the 1st application area, the changes in the reflectance and luminescence characteristics of paper and writing induced by exposure to sunlight and strong UV light were measured with the QHSI instrument. As an example for the 2nd application area, the SENTINEL instrument was used to measure a TLC plate with ink samples. Based on the large number of calibrated reflectance and luminescence images, one can generate false-color images that facilitate the visual comparison of the positions and intensity of bands. A more detailed analysis is possible by extracting numeric cross-section data along the different sample traces.

What is the Basis for a Handwriting Elimination?

Ronald N. Morris, B.S.¹ and Gerald B. Richards, M.S. Ed.²

This paper reviews the basic elements necessary to eliminate an individual as having written a questioned body of writing based on that person's handwriting characteristics. In addition, a review of the pertinent literature and foundational basis necessary to reach such definitive opinions will be thoroughly discussed. The essence of this paper is to research the literature regarding the elimination of a person as the author of handwriting by means of a handwriting examination, to delve into what may be the cause

for an forensic document examiner's (FDE's) opinions relating to eliminations that are in error, and to delineate the criteria necessary to eliminate a writer based on established principles. The authors have observed over the years that some FDEs have either lacked sufficient training in what constitutes the basis for elimination or have not fully understood the criteria necessary to make that determination. It has become apparent to the authors through their own case work, discussions at technical meetings, and general feedback from other qualified FDEs that elimination-type opinions are too frequently offered without a sound demonstrative basis for such opinions. In some instances we have observed that the eliminations are a product of insufficient training by the FDE offering the opinion; a poor understanding of the criteria necessary for an elimination; or, in some matters where training is proper, an improper application of the principle that the FDE had learned in training.

Although the determination of identification and elimination are on opposite ends of the opinion scale, the criteria needed to reach these opinions are considerably different. However, both are based on a writer's skill level; the characteristics, qualities, and features of the writing; the quantity and complexity of the examined writing; the full range of variation of the writer; and the occurrence of outside or accidental factors that can influence a writer and subsequently the writing.

To conclude that a known writer did not write a questioned handwriting, the FDE must determine that the known writer could not and did not write the questioned writing under any circumstances, including, but not limited to, intentional or accidental distortion, more than one writing style, writing position, drugs, or other transitory or permanent factors, etc.

In most instances involving signatures and short writings, the evidence in the writing is insufficient to make such a determination. The key element to eliminating a writer is for the FDE to fully understand that it is the combination of differences, taken collectively, that determines the truly significant differences that provide the basis for the elimination. The authors have noted that even minor variations in writing characteristics, qualities, and features have been deemed so significant and individualistic by some FDEs that they have maintained that these superficial differences are sufficient to eliminate a writer.

An Update of the Typestyle Classification Program (TYPE) into a Windows® Based Format (WinType)

Karen J. Nobles

In the late 1980s, Dr. Philip D. Bouffard began development of the 1st computer-based typewriter typestyle classification program, which he called "TYPE." This program, based on the manual typewriter classification systems of the time, required a DOS-based operating system and used a searchable database to limit the number of known type specimens that had to be compared with a questioned typewritten text. Dr. Bouffard gave his time and this program to the forensic document examination discipline in order to further the science. Over the years, this author has used Dr. Bouffard's program to solve many typewriter questions and, in appreciation, endeavors to update the program to run in the current Windows® environment so that the forensic document community can continue to benefit from Dr. Bouffard's foresight and generosity.

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The Use of Principal Component Analysis to Provide Objective Methods for the Examination of Arabic Signatures

Ahmed Al Haddad, Peter C. White, Anthony M. Cowell

The natural variation within an individual's Arabic signature is studied using Principal Component Analysis (PCA) with orthogonal rotation of the components. Fifty replicate analyses of sixteen features, measurable or classified by a numerical coding system, were analysed for a legible and an illegible type of signature. With either type of signature this PCA method provides an objective, robust and simple routine for identifying the features and importantly associations between features. Using only the measurable features, the results from two trials proves the method could potentially assist in confirming the authenticity and identifying forgeries for both legible and illegible types of signatures. From studying the effect of sample size it is recommended that no less than twenty-five control signatures should be used to ensure reproducibility and confidence in reporting any results when using this statistical method of analysis.

Online Proficiency Testing for Signature Comparison by Forensic Document Examiners and Non-Examiners

Lindsay Holmes, Brent Ostrum, Andrew Barton

The present study was conducted to develop and test a new online method of proficiency testing for the completion of a signature comparison trail. The web-based test consisted of 14 specimen signatures and 50 questioned signatures with the latter consisting of 8 'genuine' signatures and 42 'simulated' signatures. Opinions regarding the authorship of each questioned signature were submitted by a group of 32 Forensic Document Examiners (FDEs) as well as a group of 32 non-examiners. Results from the online test for FDE participants were compared with the results from a paper-based signature comparison trial conducted by La Trobe University Forensic Expertise Profiling Laboratory that had used signatures from the same specimen writer and simulators. This comparison revealed that there was no significant difference between the FDEs who participated in the online study and the FDEs from the La Trobe study. In addition, FDE participants performed better than the non-examiner group, providing more correct opinions and fewer misleading opinions. The results of the study provide further validation of the existence of an expertise in the area of signature identification. Support is also provided for the use of online proficiency testing as an alternative to the traditional paper method.

The Effects of Constraining Signatures

Dainis Simsons, Rosalind Spencer, Sofia Auer

Forensic document examiners are often asked to determine the authenticity or otherwise of signatures on official government forms, most of which use a line or box for the signature space; but the extent to which such lines and boxes affect a natural signature is relatively unknown. Six types of constraints encountered in everyday signature examinations were investigated. All constraints significantly affected the size of the signatures, and anomalies appeared in the constrained signatures (extra artifacts, reduction in complexity, lack of fluency, and hesitation marks).

Liquid Lead Pencils Revisited

Brenda N. Lanners

In most cases, a Forensic Document Examiner has little trouble differentiating between the stroke made by a pencil and one made by a rollerball pen or a ballpoint pen. The liquid lead pencil, however, presents a more challenging stroke appearance which is a hybrid of the fluid ink of a rollerball pen and the striations of a ballpoint pen. This study will compare characteristics of the stroke lines of liquid lead pencils, graphite pencils, ballpoint pens, rollerball pens and gel pens, on original and photocopied documents. Forensic Document Examiners should be aware of the stroke characteristics of a liquid lead pencil when making a determination as to the writing instrument used on a document.

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Impressions/Ink Intersection Sequencing — A Comprehensive Overview

Robert W. Radley and Brian S. Lindblom

This paper explores the sequencing technique between ESDA detectable impressions and ink strokes. The method assists in the determination of the execution order of visible ink lines and intersecting ESDA impressions. Critical factors, suggested procedures, interpretation and tips on conducting the work are considered and addressed in detail. Consideration is also given to conflicting papers on this topic.

The Frequency of Occurrence of Specific Handwriting Characteristics within a Limited Population

Kate Savoie

This study was designed to determine how frequently a specific population continues to use the class characteristics of certain cursive words, numbers, or letter combinations from the learned copybook style or the frequency at which the population deviates from that copybook style. Nine different elements were evaluated, including three words, two numbers, two capital letters, and two letter combinations. For each of the nine elements, three to five class characteristics were classified according to the copybook style and a side by side comparison was conducted to determine if a research participant within the population studied retained the characteristics taught to them, or if they deviated from that style. The results were tabulated and calculated to determine the frequency with which the participants used or did not use the copybook style five years after graduating from high school.

Skill Characteristics of Forensic Handwriting Examiners Associated with Simulated Handwritten Text

Carolyne Bird, Reinoud D. Stoel, Bryan Found and Douglas Rogers

The assessment of the process of production of handwriting (naturally written, disguised or simulated) is an important step in forensic examinations and may impact on any authorship opinion offered. However, there is currently little empirical data on the skill of forensic handwriting examiners in discriminating between disguised and simulated writing processes. The results reported here form part of a larger investigation to that end. The trial consisted of 100 pairs of handwriting samples, each with a naturally written comparison sample, and a questioned sample that was either disguised by the comparison writer, or written by another writer attempting to simulate the comparison writer's handwriting features. The simulated writings were made with or without practice and with or without a direct model of the target text in the comparison writer's handwriting. Analysis revealed no significant differences between the correct or misleading (erroneous) scores of any of the combinations of simulated writing types. Simulated writings attracted high misleading and inconclusive scores indicating that the predictor features that FHEs use to form opinions on the un-natural writing samples in this study were not effective.

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A Study on the Stability and the Utility of Satellite Droplets for Classification of Ink Jet Printers

Liu Ning

The author investigated the stability of satellite droplets as either class or individual characteristics in the printouts from 40 types of Hewlett-Packard and Canon ink jets. Observation established that satellite droplets produced by one ink jet device might vary in appearance with different print modes, ink, media and other factors. Given their lack of repeatability, they are not considered to be characteristics that can be relied upon by FDEs for ink jet printer classification or identification. However, the forensic value of satellite droplets should not be totally ignored. Their structure can indicate the properties of the ink, and possibly the brand of printer. They are very useful for ascertaining certain characteristics for ink jet classification, including halftone dot, nozzle arrangement, and stepping of paper feed. They can also assist in determining print modes, without which no ink jet output can be produced. Therefore, satellites should be taken into consideration when FDEs are examining an ink jet -printed document.

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Conducting a Forensic Examination of Electronically Captured Signatures

William J. Flynn, B.S. D-ABFDE

The Uniform Electronic Transactions Act (UETA-1999) gave electronic signatures the same legal weight, as original (hand-made) signatures. As a result, a proliferation of signature capture devices has entered the market place. One of the most commonly used capture devices is the electronic signature tablet, which acquires electronic versions of signatures executed as part of a transaction. Typically, these electronic representations of a signature are embedded (or associated with) the document requiring the signature in such a way as to prevent tampering. Research conducted by the author for Topaz Systems, Inc. (a leading producer of electronic signature tablets and software) and studies necessitated by actual casework, have shown that signatures captured at a rate of 100Hz or faster contain sufficient detail and fidelity to arrive at reliable forensic conclusions as to authorship. In addition, Microsoft Excel™ can be used to produce very accurate graphical plots from the captured raw data.

Stone Paper: An Overview of its Characteristics and the Impact They May Have on Forensic Document Examinations

Haley A. Elliott, M.F.S. and Lisa E. Stadmeier, M.S.F.S.

Stone paper is comprised mainly of calcium carbonate and plasticizers. Unlike pulp paper, it is manufactured without large amounts of water and chemicals. Due to its unique composition and manufacturing process, stone paper manufacturers claim it is: more environmentally friendly than traditional pulp paper, 100% recyclable, water, grease and tear resistant, and bio-degradable. Stone paper has been commercially available for ten years, and in the past three years has become increasingly available in household consumer-use products including notebooks and inkjet photo paper. As it becomes more available, the forensic community will likely encounter stone paper in casework. This article seeks to educate the forensic document community about stone paper characteristics, evaluate some of the manufacturers' claims outlined above, and describe special considerations that must be taken during forensic document examinations involving stone paper. Actions and associated examinations undertaken include: indented impressions, typewriting, non-destructive ink (writing instruments, toner and inkjet printing) examination, tearing, folding and stapling, water and grease interaction, and environmental exposure. Results of the current study showed that examination of stone paper can be conducted in a manner similar to traditional pulp paper, with a few exceptions regarding indented impression examinations and fracture matching.

Statistical Evaluation of the Reproducibility and the Influence of Paper on the Analysis of Black Gel Pen Ink Using Laser Desorption Ionisation Mass Spectrometry

Aleem Iqbal, Paul Majcherczyk, Céline Weyermann^{2*}

Laser desorption ionisation mass spectrometry (LDI-MS) has demonstrated to be an excellent analytical method for the forensic analysis of inks on a questioned document. The ink can be analysed directly on its substrate (paper) and hence offers a fast method of analysis as sample preparation is kept to a minimum and more importantly, damage to the document is minimised. LDI-MS has also previously been reported to provide a high power of discrimination in the statistical comparison of ink samples and

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has the potential to be introduced as part of routine ink analysis. This paper looks into the methodology further and evaluates statistically the reproducibility and the influence of paper on black gel pen ink LDI-MS spectra; by comparing spectra of three different black gel pen inks on three different paper substrates. Although generally minimal, the influences of sample homogeneity and paper type were found to be sample dependent. This should be taken into account to avoid the risk of false differentiation of black gel pen ink samples. Other statistical approaches such as principal component analysis (PCA) proved to be a good alternative to correlation coefficients for the comparison of whole mass spectra. **Keywords:** Ink Analysis; LDI-MS; Reproducibility; Paper; Gel Pens; Questioned Document

SCANNED IMAGES: How Well Do They Depict the Subtle Features in Handwriting?

Janet Fenner Masson

It is increasingly common for companies and government agencies to retain scanned images of documents in lieu of originals. In many instances, the original document is destroyed after imaging. As a result, the best image of a document may be a digital image. This project is not intended to be an inquiry into the parameters document examiners should use in scanning documents for their own records. Rather, it is a study of digital images captured using guidelines like those utilized by companies and agencies in maintaining records. A study was made to determine which features are reliably and accurately depicted in these scanned images and which are not. A comparison of the image quality obtained using various scanning parameters and transmission methods was made. In addition, examinations from originals, from first-generation photocopies, and from scanned images were considered.

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Examination of paper and toner in page insertion/substitution cases using TLC, GC-MS and FT-IR microspectroscopy

Valery Aginsky, PhD

The comparison of paper and toner of each sheet (or certain pertinent pages) of a multi-page document produced with toner-based electrophotographic technology may help: (A) to determine if there have been page insertions or page substitutions; or (B) to test a hypothesis that multiple documents, which were supposed to come from different sources, have a common source.

This article shows that a combination of three analytical methods, thin-layer chromatography (TLC), gas chromatography-mass spectrometry (GC-MS), and reflectance Fourier transform infrared (FT-IR) microspectroscopy, provides high discriminating power with regard to both paper and toners that cannot be distinguished by non-destructive (optical) techniques. These three analytical methods may allow the examiner to achieve a high level of certainty when evaluating which of two competing hypotheses is more probable:

- (Case A) the “prosecution” hypothesis, H_p , that certain pages in the document have been substituted, or the “defense” hypothesis, H_d , that no page substitution has occurred since the initial production of the document;
- (Case B) the “prosecution” hypothesis, H_p , that multiple documents, which were supposed to come from different sources, have a common source, or the “defense” hypothesis, H_d , that all the documents came from their respective origins as indicated on the documents.

The Use of Simple Dimensional Measurements in the Analysis of Simulated Signatures: A Preliminary Study

Rukshana Boshir, MSc and Andrew, W. G. Platt, PhD

The ability of participants to simulate the width, height, and width: height ratio of simple and complex target signatures has been explored. The natural variation of the target signatures was evaluated over 29 and 28 signatures for the simple and complex signatures respectively. A group of 20 participants were provided 12 simulations of each signature on lined and plain paper. Paired t-tests show that the complex signature was more consistently reproduced than the simple signature. Single factor Analysis of Variance (ANOVA) followed by post hoc Tukey Honestly Significant Difference (HSD) tests showed that the complex signature was more easily simulated.

Frequency of Selected Hand Printing Characteristics Occurring within a National Population: The *New International Version Bible Across America*®

Brett M. D. Bishop

Statistical analyses of data gathered for the hand-printing characteristics of a large national population of writers has yet to be undertaken in the field of document examination. Previous, smaller studies

documented the frequency of characteristics (e.g. skill, writing systems, style, and letter formations), but have not been updated for nearly twenty years. This research project examines hand-printing characteristics, specifically letter formations, to discover data which can be analyzed to establish frequency of their occurrence.

The source for this project is the *New International Version Bible Across America*® published by Zondervan. This version contains the writing of more than 31,000 individuals representing all fifty American states and abroad. Data for this study are based on a sample set of 500 people. The characteristics studied included various formations of “a,” “n,” and “r.” This research will be compared with previous findings from other studies, the most recent of which occurred in 1992 and will include recommendations for future study regarding the distinctiveness of hand-printing characteristics.

Using Acceleration/Deceleration Plots in the Forensic Analysis of Electronically Captured Signatures

Kathleen Annunziata Nicolaidis

A research study was conducted to determine if analysis and comparison of acceleration/deceleration plots of signature data captured by electronic signature tablets would provide meaningful evidence in an examination of electronically captured signatures. This research focused on data collected by signature tablets produced by Topaz Systems, Inc., one of the largest suppliers of digital capture devices. William Flynn, in his article “Conducting a Forensic Examination of Electronically Captured Signatures” (published in the June 2012 edition of the ASQDE Journal), noted the visual differences in the plots of genuine and simulated signatures. Further research was conducted to determine how useful plotting the acceleration/deceleration of electronic signatures would be in a forensic examination and what reliable conclusions could be made from their analysis. The study hypotheses were that acceleration plots will be consistent for one writer; that simulated, traced, and spurious signature plots will be visually different from those of genuine signatures; that there will be a noticeable difference between signature plots of different writers; and that the comparison of acceleration plots will be a useful tool for signature authentication.

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A Comparison of Class Characteristics Among Several Crosscut Shredders

Matthew McDonald, BS and Larry A. Olson, MFS

Although a handful of papers have been written on the re-assembly of shredded documents, little is known about how shredders of different makes and models operate. The purpose of this project was to distinguish crosscut shredders of different makes and models by determining the manner in which they shred. A total of seven shredders were evaluated by means of their paper shred and machine characteristics. Several of these characteristics include mean width and length of the shred, physical appearance of the shreds, width of the shredder throat and the type of cutting mechanism within the machine. Three of the seven shredders were of different makes, while two pairs of machines were of the same make and model. The two primary objectives of this research were: first, to analyze the output of the seven shredders; and second, to determine and compare the class characteristics of each individual shredder. It was also expected that possible indications of individual characteristics might be detected between the shredders of the same make and model.

An “Ideal” Methodology for Manually Assembling Crosscut Shredded Documents

Larry A. Olson, MFS

This paper outlines a procedure the author developed while working an “ideal” case—the reassembly of a small bag of crosscut shredded documents. The shredded pieces, or “shred” were made up of several colors of paper, with a variety of handwritten or printed entries.

The author discovered that, by making some rudimentary measurements of the shredded particles, assembling a small portion of a document, and observing how the crosscuts occurred, it was possible to predict and visualize the pattern into which the document was shredded. With this pattern, and other techniques used to sort and arrange the shredded pieces, the manual reassembly of the document was successfully completed.

Ink Dating—Comparative Examination of Inks on Documents using Optical and Chemical Methods

Valery N. Aginsky, PhD

Comparison of inks on the same or multiple documents is one of the ink dating approaches that determines and compares the physical and optical characteristics (including ink line morphology defects) and chemical composition of writing inks on documents. In this work, writing samples produced by 400 ballpoint pens (200 new and 200 used pens) were examined under the microscope, and the relative frequency of occurrence of various morphology defects, including certain reproducible ink line morphology defects that can be used for the purposes of relative ink dating, was determined. Also, the paper outlines typical case situations in which a comparative examination of inks on documents using optical and chemical methods is used for dating purposes.

Development of a Supplemental Technique to Increase Visualization of Handwriting Indentations in Crumpled Documents with the Use of an Electrostatic Detection Device (EDD)

Kate Savoie, B.S.

Forensic document examiners (FDEs) receive questioned documents in all sorts of conditions: chemically processed, folded, crumpled, wet, frozen, charred, wadded, or a combination thereof. Application of an Electrostatic Detection Device (EDD) is one of the key examinations performed on original questioned documents. These examinations have elicited superb information in the form of latent handwriting indentations as well as pattern impressions that may indicate a printing process, which otherwise might have remained unseen. Crumpled or wadded documents have proven a problem in the area of EDD examinations as the toner particles may adhere to the uneven and prominent creases and folds as opposed to the more subtle and delicate latent handwriting indentations or printing process impressions. This research attempts to develop a supplemental EDD technique in which increased relative humidity (RH), pressure by use of a weight, and/or a stretching technique may be applied to a crumpled piece of paper containing latent handwriting indentations after a traditional EDD exam has already been applied that did not yield fruitful results. These secondary techniques have proven in this research to allow for increased visualization of latent handwriting indentations.

Imaging Methods and Quantitative Measurements for the Characterization of Digitally Printed Materials

Daniel Burge, Nino Gordeladze, Kristin Smith, Jordan Briscoe, Ryan Boatright and James Reilly

Over the last five years, researchers at the Image Permanence Institute at the Rochester Institute of Technology have been developing an imaging strategy and a set of quantitative measurements that can be used to characterize modern digital print materials (both images and documents). While the goal of the project has ultimately been to enable personnel in cultural heritage institutions to identify their collection materials, the approaches should also be helpful to the field of forensic document examination. The imaging methods include varying the angle of lighting as well as the level of magnification. Structures such as surface gloss and texture as well as dot morphology and pattern can be assessed and compared to known print types. Additional, unique traits such as colorant bronzing, differential gloss, anti-block layers, etc. can also be used to narrow down the identification of particular print examples. This paper will describe the main approaches used for both imaging and quantitative measurement of print samples along with descriptions of where support tools can be found online.

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Are Simple Signatures So Easy to Simulate?

Liv Cadola, Pierre Margot, Raymond Marquis

Is it possible to perfectly simulate a signature, in the particular and challenging case where the signature is simple? A set of signatures of six writers, considered to be simple on the basis of highlighted criteria, was sampled. These signatures were transferred to forgers requested to produce freehand simulations. Among these simulations, those capable of reproducing the features of the reference signatures were submitted for evaluation to forensic document experts through proficiency testing. The results suggest that there is no perfect simulation.

With the supplementary aim of assessing the influence of forger's skills on the results, forgers were selected from three distinct populations, which differ according to professional criteria. The results indicate some differences in graphical capabilities between individuals. However, no trend could be established regarding age, degrees, years of practice and time dedicated to the exercise. The findings show that simulation is made easier if a graphical compatibility exists between the forger's own writing and the signature to be reproduced. Moreover, a global difficulty to preserve proportions and slant as well as the shape of capital letters and initials has been noticed.

Predictors of Disguised and Simulated Handwritten Text

Carolyne Bird, Bryan Found and Doug Rogers

Assessing the authorship of writings created using disguise and simulation behaviour has been reported to be problematic for forensic handwriting experts (FHEs). When examining questioned disguised and simulated samples and providing an opinion on process, a propensity has been found for calling simulated samples disguised. These results suggest that FHEs' expectations of the predictor features of these unnatural writing types are not accurate. This paper investigates the relationship between FHEs' responses on the process of production of questioned disguised and simulated handwriting samples and their verbal statements relating to the features they observed as indicative of the particular unnatural writing behaviour. A clear relationship between these will enable elucidation of predictor features of disguised versus simulated writings. Results suggest that the identification of altered slope in a questioned sample when compared to a naturally written sample may be a predictor of disguise behaviour. Features of construction and the presence of tremor may be used as predictors of simulation behaviour in questioned samples. However, the diversity in disguise strategies employed and the discordant responses of FHEs impose limitations on the analysis undertaken. A predictor model could be created based on the results of a concordant group of experts and would require testing on a validation set.

An Examination of the Techniques for Sequence Determination of Original Writing Ink and Toner Printing

Kevin P. Kulbacki

Forensic Document Examiners frequently conduct examinations to determine the sequence in which intersecting entries were written. This paper arises from casework and subsequent research undertaken to determine the reliability of various techniques for the removal of toner in a sequence examination.

Tests were conducted using a Canon Color Image Runner C1022i printer and a variety of different writing instruments. The test intersections were prepared using a standardized template with varying sequences of ink before toner and ink after toner. The techniques being tested included using different sharp tools for the removal of the toner as well as a process of pre-treating the document through freezing. The techniques being tested are destructive in nature and therefore this study is being completed primarily as a theoretical exercise.

Shredded Document Reconstruction

Donald Moryan

A technical note that discusses one method of reconstructing shredded documents. Along with the preferred method and procedures of reconstructing shredded documents, a short history of paper shredders and different types of paper shredders are presented.

The Role of Print Mode Determination for Classification of Inkjet Printers

Ning Liu, M.A.

The purpose of this paper is to propose an effective method for the classification of inkjet printers. One of the challenges when examining inkjet-printed documents is the variety of print modes that can be used. In this study, 80 different models of inkjet printers were used to print samples in various print modes, which were then examined using a microscope. It was shown that changing print modes resulted in variation of some features in print, such as the increment of paper feed stepping, satellite droplets, halftone algorithm, halftone dot structure, and color configuration. However, the laws that govern this variation can be understood and followed. The author drew a conclusion that print mode determination could contribute to the reliable and efficient classification of inkjet printers, and should be considered as an essential part of the examination.

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Arabic-Illiterate Forensic Handwriting Analysis: A Pilot Study to Further Investigate the Ability of Arabic-Illiterate Examiners to Judge the Accuracy of Simulations of Arabic Signatures, Compared with Arabic-Literate Examiners

Abdulaziz Al-Musa Alkahtani, MSc, PhD, MFSSoc

This article extends the study in Al-Musa (2010) examining whether forensic handwriting examiners (FHEs) who are illiterate in Arabic can detect Arabic forgeries as accurately as FHEs who have native fluency in Arabic. Because large numbers of real forgeries are difficult to find, the forgery data in these two pilot studies consisted of simulations, produced by 100 native Arabic writers, of two Arabic signatures. Two experienced Arabic-literate FHEs and two experienced Arabic-illiterate FHEs then judged the accuracy of these simulations, using standard forensic handwriting analysis methods. Their judgments of four narrow elements of the simulations (Size, Spacing, Arrangement, and Slant), as well as two of the broader elements studied in the 2010 article (Form and Line Quality), were compared. As in the earlier study, the judgments of Arabic-literate FHEs did not differ significantly from those of Arabic-illiterate FHEs (p 5 0.05). Thus, a second statistical study adds support to a widespread view held by FHEs, based on anecdote and experience, that literacy in a script is not needed to detect forgery in that script. Other considerations, however, suggest that a native writer of a script may have advantages over an illiterate in that script in conducting forensic handwriting analysis.

Effect of DNA Tape Lifting on the Ability of the ESDA® to Recover Latent Indentations in Paper

Melanie Holt¹, Alison Sears², Chris Lennard³

Questioned documents are often received into forensic laboratories requiring examinations for both trace DNA and latent indentations using an electrostatic detection device (EDD) such as the Electrostatic Detection Apparatus (ESDA®). Such documents can include extortion notes, threatening letters, drug ledgers and paper items related to white powder incidents, to name a few. Debate often arises as to which of the various examinations should be undertaken first. Assessments regarding examination sequencing need to be made on a case-by-case basis with the knowledge that each examination has the potential to compromise others.

This article focuses specifically on the effect that the tape lifting process has on the ability of the ESDA to recover latent indentations in paper. The research showed that the tape lifting process had a detrimental effect on the ability of the ESDA to recover and develop latent indentations. At worst, the tape lift can cause tears and areas of the paper's surface to be lifted whilst at the same time effectively 'masking' the indentations, making them difficult for the ESDA to detect. At best, there is fibre disturbance that results in the development of background noise on the ESDA lift; this reduces visibility, definition and legibility of the developed indentations. Given these results, in cases where it is decided that both examinations are required, the ESDA examination should be conducted prior to tape lifting for trace DNA.

Do People Always Disguise Their Writing the Same? The Trilogy

Marie E. Durina, Steven G. Drexler and Rigo Vargas

Determining whether handwriting is naturally or unnaturally prepared is a common challenge for forensic document examiners (FDEs) and many variables must be taken into consideration during such an examination. Some issues include the writing instrument, writing medium, nature of the signature, age of the subject(s), health of the writer, and the date of the writing. The final answer being sought, however, comes down to one of three possibilities: the writing is genuine, the writing was forged by another via freehand simulation or tracing, or the writing was deliberately disguised by the subject (often called auto-forgery, or auto-simulation.) This paper discusses the results of a research project conducted to determine the most frequently used strategies writers use when attempting to disguise handwriting, whether writers tend to use the same form of disguise each time, and if the availability of deliberately disguised known specimen writing aided FDEs in their examinations.

This research study focused on disguised writings and signatures prepared by subjects who intended to deny them at a later date. A deliberately disguised document was obtained from more than 50 subjects along with natural and disguised known specimen writings. These writings were collected by 3 forensic document examiners from 3 different geographic regions of the U.S. The specimens were then used in side-by-side examinations and comparisons with their disguised writings. Strategies used by the writers to disguise their writing will be discussed. Potential sources for error in certain problematic samples will also be discussed.

The hypothesis of the forensic document examiners conducting this study was that, like one's natural writing, a person's disguised writing will contain individual characteristics that will be repeated again and again whenever an attempt at disguise is made. Two prior research studies have supported this premise, and these will also be discussed. It is also hypothesized that the comparison of said characteristics, in a side-by-side examination of questioned to known writings, also like one's natural writing, can lead to the identification of a writer of disguised writing. If this theory is correct, it may be necessary to require that the collection of requested known exemplars include a set of "disguised" known samples as well as normal, natural writing specimens.

Jay Fordyce Wood

Larry A. Olson, MFS

THE LOEB-LEOPOLD CASE

(From the Standpoint of the Handwriting, Pen Printing, and Typewriting Expert)

J. Fordyce Wood

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A Revealing Writing that has been Covered Using Correction Tools

Anna Guzowski, B.S., Kellen Millner, MSFS, Christopher Yue, Eliot Springer, M.Sc.

One particular challenge encountered by the forensic document examiner is that of obliterations through use of correction utensils and opaquing solutions (eg. Wite-Out®). Underlying writing can be difficult to distinguish due to this type of obliteration. In the past, various methods have been implemented to deal with these types of evidence, such as physically removing the solution. However, this method has the potential to destroy the original evidence in the process (1,2). An alternate non-destructive method for the visualization of the underlying writing is preferred. ESDA® and the VSC® are both non-destructive techniques widely used in the analysis of questioned documents. The ESDA® was proposed and examined as a novel method for visualizing this type of obliterated writing. This non-destructive method was then compared to that of using the VSC® for this same type of examination. The evaluation was carried out through the use of a variety of writing instruments, inks and printing methods. A series of samples consisting of handwritten, typewritten, and non-impact printed material was prepared and sections of each were covered with a different correction tool. Both the ESDA® and VSC® were used to view the underlying writing. The ESDA® was able to distinguish the underlying writing from the front in three of the eight samples where the correction tape was used and from the back in three of the eight samples where correction fluid was used. Surprisingly, for all other samples, the ESDA® did not succeed in revealing the obliterated writing. In all cases, however, the VSC® was able to generate a legible image of the original writing. In short, the VSC® was exceptionally effective at visualizing writing obliterated by opaquing solutions. There might, however, be some situations where the ESDA® may be more advantageous.

Investigating Forensic Document Examiner Opinions on Signatures in a Foreign Script

Rosalind Spencer

There have been court challenges in various countries around the world bringing into question the validity of forensic document examiners (FDEs) expressing expert opinions on writing systems other than those with which they are familiar. A study was designed to assess whether FDEs are significantly better at evaluating the authenticity of questioned signatures in a familiar script than FDEs who are faced with an unfamiliar one. Volunteer FDEs familiar with Chinese script, those unfamiliar with the script, and a group of laypeople were provided with a series of small validation tests in a blinded fashion. The theoretical paradigms used by FDEs to form the basis of expert opinion in this area were explored, together with a discussion on how these results may be generalised to the overall FDE population, given the limitations of such a study.

A Study of Various Factors Affecting Stamp Identification

Chi-Ming Pang, Janesse W.S. Hui and Chi-Keung Li

Stamp identification is performed by matching unique defects present on the stamp face to those on the impressions. Unique defects are usually introduced onto the stamp face through wear, tear, and day-to-day usage. Defects can also be introduced at the manufacturing stage. However, depending on the cause, these can be either unique to an individual stamp or apparent in all stamps produced using that particular mold.

In addition to defects, other essential factors that should be considered when undertaking a stamp examination are explored in this paper. These include: stamp shrinkage rates during normal use and how these rates are affected by changes in temperature and humidity, the effects of stamp re-inking, the effect of sunlight on the appearance of stamp impressions, the possibility of a duplicate stamp being used to make a questioned impression, and the “smudging” effect. The paper also discusses the significance these factors should be given when formulating opinions.

Ink Aging Testing—Do Preceding Indentation Examinations Affect Ink Aging Parameters?

Valery N. Aginsky, PhD

This paper discusses various aspects of two ink aging methods involving the analysis of volatile ink components: the Sequential Extraction Technique (SET) and the Solvent Loss Ratio Method (SLRM). Multiple ballpoint ink writings of various ages were tested by the SET and SLRM both before and after the pages bearing the writings were examined for indented writing impressions using an electrostatic detection apparatus (ESDA). The results obtained show that the indentation examination does not cause any significant changes to the ink aging parameters that are measured by the SET and SLRM.

Editorial (Letter to the Editor)

Forensic Document Examination Capacity Building

Samiah Ibrahim

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AIn Situ Analysis of Ink Lines Made by Blue and Black Ballpoint Pens by Reflectance and Luminescence Spectroscopy Using the VSC6000HS

Saqar Alzaabi and Gordon Sharfe

In situ discrimination of blue and black ballpoint pen ink lines on paper was performed using the visible-infrared reflectance and visible-infrared luminescence spectroscopy functions of the VSC6000HS. Ink lines from 30 blue and 30 black ballpoint pens were examined. It was found that about 92% and 94% of the ink lines of the blue and black ballpoint pens respectively could be distinguished using these methods.

The outcomes of this project demonstrated that this methodology of differentiating ballpoint inks did not only provide reproducible results, but also offered a satisfactory, simple, rapid, non-destructive and objective way of differentiating ink entries of blue and black ballpoint pens.

The results have also demonstrated that the paper color has an effect on reflectance and luminescence spectra obtained by VSC6000HS. As a result, comparing ink entries on different colored-paper substrates by these methodologies is not acceptable.

Line Direction Determination of Ballpoint Pen Ink Writing

Andrea Devlin, Claire Graydon and Steven J. Strach

Determining the direction in which written lines have been executed is an important part of the work of the forensic document examiner. This information can be of key importance in the comparative examination of questioned and specimen signatures and handwriting and also in determining the presence of altered writings (Fryd, 1975).

The purpose of this paper is to report on an initial assessment of the reliability of a documented method of determining ballpoint pen ink line directions by observing the preferential build-up of ink on the up-stream side of paper fibres.

During 2013 and 2014 document examiners with several organisations in Australia took part in a blind trial. Each examiner was asked to determine the direction of writing of forty short, straight lines written with two black ink ballpoint pens. The samples were prepared so that other direction information was excluded. Participants provided an unqualified or qualified determination or an inconclusive result for each line. Examiners' results were assessed to determine the overall reliability of the method. Factors that appear to allow a confident determination and factors that detract from making a determination are discussed.

The Effects of Constraint on a Signature's Static and Dynamic Features

Kristen Fazio

Forensic document examiners are tasked daily with determining the authenticity of signatures. The majority of these signatures are found on a line, within a box or within text. A major concern with this type of examination is the presence of these lines, boxes and text, since they can pose a form of constraint resulting in variations to an individual's natural signature. This study examined the effects of constraint on an individual's signature with the use of a digitizing tablet and inking pen to measure both the dynamic and static characteristics of the signature. Forty participants ranging in age from 16 – 83 provided a series of signatures for a total of 2400. Each participant signed in the presence of five different constraints, mimicking actual Canadian Government forms, including: a 4.7 cm line, a 6 cm x1.2 cm box, a 4.8 cm x 0.96 cm box, a 6.4 cm length and 0.4 cm height space within text, the Adult General Passport Application box produced by Passport Canada and a blank sheet as a control. This study suggests that when constraint is introduced, the pen speed, pen jerk, overall length, ascenders and descenders all vary significantly from that of the unconstrained signature. Pen pressure was the only feature to not show significant difference in the presence of constraint. In addition to these dynamic characteristics, anomalies such as extra artefacts, variation in complexity, hesitations, health issues and signs of anxiety were observed. This study demonstrates the impact that constraint has on a signature and indicates to forensic document examiners the need to carefully consider and evaluate these variations in the examination process.

Computer-Scored Test Answer Marks, Aka Bubble Marks: How Individual Are They?

Janet Fenner Masson

Funding for schools is increasingly based on the results of standardized tests administered to the student. In administering these tests, many states and education-related organizations use computer-scored answer sheets. On these sheets, a writer indicates his or her answers by using a pencil to fill in printed circles or ovals, making what are sometimes called bubble marks or grid marks. These answer sheets are then graded or scored electronically.

Document examiners are sometimes asked to examine computer-scored test answer sheets in order to determine whether they were completed by a specific student or whether they were each fully completed by one person. Since the sheets typically contain handwriting other than the answer marks themselves, the opinion reached, if any, is often based primarily on evidence in the handwritten text. However, sometimes the answer marks themselves become the issue.

The questions studied in this project are (1) whether writers have a consistency in making answer marks, (2) whether answer marks have individuality, (3) what conditions need to exist in order to reach a meaningful opinion about these marks, and (4) how the marks should be examined.

Spatial Pyramid Matching-based Multi-script Off-line Signature Identification

Ranju Mandal, Srikanta Pal, Partha Pratim Roy, Umapada Pal, Michael Blumenstein

Among all of the biometric authentication systems, handwritten signatures are considered as the most legally and socially accepted attributes for personal identification. The objective of this investigation is to present an empirical contribution towards the understanding of a signature identification technique involving multi-script off-line signatures. In our experiment, SIFT (Scale-Invariant Feature Transform) descriptors with Spatial Pyramid Matching (SPM)-based approaches have been used for feature extraction of signatures written in multiple scripts. Support Vector Machines (SVMs) are employed as the classifier in this experiment. 300 classes from the publicly available GPDS[16] dataset consisting of 7200 (300×24 ; 24 signature samples in each class) genuine signatures, 300 classes from a Devnagari signature dataset consisting of 7200 (300×24) genuine signatures and 200 classes from Bangla signature dataset consisting of 4800 (200×24) genuine signatures have been considered for this experiment. The signature identification experiment is conducted on these three datasets separately as well as 800 classes from a combined dataset of English, Devnagari, and Bangla signatures. The identification accuracy on the datasets is encouraging and 99.32% accuracy was obtained on the combined dataset of signatures, while 99.95%, 99.25% and 99.57% accuracy were achieved on experiments conducted separately on English, Devnagari, and Bangla signature datasets.

Keywords: Document image retrieval; Signature identification; Dense SIFT; Bag-of-Features; Spatial Pyramid Matching

Near-Infrared (NIR) lighting, in support of determining the sequence of non-intersecting media on documents: Ballpoint Pen Ink and Laser Toner entries

Francesco Dellavalle

Certifying the entry chronology of signatures or printed text on documents represents an important issue for the examination of forged documents. While in the case of intersecting signatures, numerous analysis techniques have been reported in the literature, much less is known about non-intersecting signatures, which also occur very often in practice.

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Exploring the significance of pen lifts as predictors of signature simulation behaviour

Tahnee N. Dewhurst, Kaye N. Ballantyne, Bryan Found

Historically, pen lifts have been considered valuable predictors of simulation behaviour. Despite this belief, there exists only limited empirical data available to characterise the extent to which unexpected pen lifts contribute to evidence in support of simulation behaviour. This study was devised to examine the frequency with which pen-lifts are observed in a population of 2280 simulated signatures as compared to a genuine signature population of 285 signatures (by 19 authors). It was found that 12% of simulated signatures featured less pen-lifts than their comparison genuine signatures, whilst 22% of simulated signatures featured more pen lifts than their genuine counterparts. The variance in pen lift incidence in the simulated signatures, as compared to the known model signatures, was found to be non-significant for both over and under representation of lifts. Sixty-seven percent of the simulations were found to successfully replicate both the number and placement of the pen lifts, when compared to their respective models. Despite the lack of statistical significance, 33% of simulations were observed to have more or less pen lifts than their genuine model counterparts and should be explored further. The results gained provide an insight into the significance of pen lifts with respect to whether or not they appear in a questioned signature, and whether the occurrence of pen lifts in questioned signatures independently provides evidence of simulated writing behaviour.

Keywords: Signatures, handwriting, pen lift, simulation, validation, questioned document examination.

Offline Signature Verification based on Centerline Similarities

Erika Griechisch and Gábor Németh

Digital signatures are becoming increasingly common in author identification. However, handwritten signatures play an important role in different aspects of life like business and the banking sector. Offline signature verification methods analyze the images and shapes of the signatures. Several methods called skeleton that is a frequently used shape descriptor that summarizes the general form of objects.

Here, we present an offline signature verification method which is based on similarity measures designed for a comparison of 2D skeleton-like shape features. The proposed method was evaluated on the publicly available SigComp2011 and SigWiComp2013 databases. The results that we obtained are competitive with those got from the systems submitted to two recent signature verification competitions.

Organising a proficiency testing programme on Chinese handwriting and signature examination in accordance with ISO/IEC 17043 requirements

Chi-keung Li, Lai-ping Chan and Siu-Kay Wong

Proficiency testing is an essential aspect of laboratory practice in all areas of testing including not only chemical analyses but physical examinations as well. Given the fact that Chinese handwriting is widely used among a quarter of the global population, the possibility exists that forensic document examiners might encounter cases involving the examination of Chinese handwriting and signatures even though the examiners might be foreign to the Chinese language and characters. Because of this, there is an imminent need of relevant proficiency testing programmes for the forensic laboratories to demonstrate their technical competency in this test area. This paper reports the details on the design and operation of a recent proficiency testing programme on Chinese handwriting and signature examination which is the first of its kind at an international level, having been conducted in accordance with ISO/IEC 17043 by an accredited provider. Feedback and comments received from the participating laboratories are also described.

Keywords: Chinese handwriting and signature examination; proficiency testing programme; ISO/IEC 17043; technical competency.

Stability, Speed and Accuracy for Online Signature Verification

Antonio Parziale, Angelo Anatrella and Angelo Marcelli

We suggest a model of signature verification based upon handwriting generation studies and derive from it the characterization of the signing habits of a subject. Such characterization is given in terms of the signature's stability regions, which are obtained by exploiting shape and temporal information conveyed by the genuine signatures captured by a writing pad. The effectiveness of the proposed method for characterizing the signing habits of a subject has been evaluated in a signature verification experiment on the Sabaci University Signatures (SUSIG) database. The experimental results, obtained by using very simple decision criteria in order to stress the role of stability regions on assessing the authorship of a signature, confirm that the proposed method captures to a large extent the behavior of the subject.

Keywords: on-line signature verification, forensic handwriting examination, signature stability.

Measuring magnetic properties to discriminate between different laser printers

Koen Herlaar, Miriam Mieremet and Mignonne Fakkell

Magnetism used to be a qualitative property to discriminate between different laser printers: magnetic single-component toners versus non-magnetic bi-component toners. Within the examination of security documents, quantitative measurements of magnetic properties are used to discriminate between genuine and counterfeited documents. The question has risen whether quantitative measurements of magnetism can also be used to discriminate between printers which use magnetic single-component toner. This paper presents a preliminary evaluation of this technology on normal laser printed documents.

This study used 72 print samples from 19 different laser printers which all use magnetic toner. For each sample the flux and magnetic induction of the toner was measured on several locations with the Regula Magmouse Model 4197. Different comparison algorithms to discriminate between printers were studied within the Bayesian Likelihood-Ratio framework. Furthermore, repeatability and reproducibility of the Magmouse were studied. This study shows that this technology has the potential to discriminate between different printers. The Magmouse is easy to operate and measurements can be done quickly without contaminating, damaging or destroying other traces on the document. However, the range of application is limited to documents printed with magnetic single-component toner.

Extraction of Signatures from Document Images for Real World Applications

Sheraz Ahmed, Muhammad Imran Malik, Andreas Denge and Marcus Liwicki

Various automatic methods for signature verification have been reported in the recent past. A common issue with nearly all of these methods is that they are built on the assumption that signatures are available pre-segmented or pre-extracted from document images. Accordingly, such systems are refined and tested on data containing signatures on the foreground and very little, to ideally no other, information in the background. The authors argue that these settings are not realistic and, in reality, experts encounter cases where signatures are written on documents having a lot of other information, than just the signatures, e.g., machine-printed text, ruling lines, logos, etc. We believe, to better assist forensic experts, a system should have the capability to automatically extract/segment signatures from documents like bank checks, forms, bills, wills, etc. This paper identifies that automatic signature extraction/segmentation from document images is a relevant problem faced by forensic document examiners and compares the various approaches currently available. Furthermore, we present an alternative method for extracting signatures from document images. The proposed method is capable of distinguishing machine-printed text from signatures and is based on a well known local feature descriptor, Speeded Up Robust Features (SURF). We evaluate the proposed method on the publicly available Tobacco-800 dataset in order to compare it to the currently available extraction methods. The research found that the proposed method was able to find all of the signatures in the document images tested. The authors see the application of the proposed method as a tool for document examiners to automatically extract signatures from document images.

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Study of Signatures Written over Extended Periods of Time

Kirsten A. Singer, Nancy M. Cox

One of the basic premises of forensic handwriting examination is that a person's writing may gradually change over time. While handwriting change is frequently evident to varying degrees, it is not known how reliably, and to what degree, change occurs.

The current study was conducted on the normal course of business signatures of 51 individuals, written over an average of four decades, in order to determine whether specific aspects of handwriting change over time. The research showed that, based on the eight characteristics defined by the authors, most individuals' handwriting changes very little over time, and that the most common change in writing occurs in line quality at an average age of 77 years. While limitations are noted in the research methods and materials, the size of the research sample provides a substantive foundation for continuing research on this topic.

Horizontal profiling, a new Method for Differentiation of Printouts of Laser Printers

Rolf Hofer, PhD

The area of characters from laser-printed documents was quantitatively measured using image analysis. A pdf text file was printed on 25 different laser printers from 6 different brands. The average value, the standard deviation and the variation of the blank area of the letters "o" within each of the sheets were calculated. The measures from the samples were compared to each other. Significant differences were found between the toner printers, in some cases even within the same brand and the same model.

It has been shown, that a horizontal profile of letter's blank area can be established. This profiling can be used as a fast, non-destructive forensic method for differentiation purposes of toner printed documents.

Thermal Ribbon Analysis Platform (TRAP): the Validation of a New Instrument for Recovering Images on Ribbons

J.C. Stephens, I. Geiman, S.M. Rohde, M.M. Rohde

This paper details the development, testing, and subsequent validation of the Thermal Ribbon Analysis Platform (TRAP). The TRAP is a computer peripheral imaging device that scans used dye diffusion thermal transfer and thermal mass transfer ribbons. The device is designed to recover and preserve photographic data on the seized cartridges without modifying or damaging the media. The system enables the user to easily and efficiently mount and scan a wide variety of cartridge formats from a desktop computer. The TRAP provides a suite of recovery and image enhancement tools from an integrated software application. The software also supports various batch related image operations to reduce post-processing time. The validation study of the TRAP demonstrates that the system is capable of imaging, tracking, and processing various cartridge form factors reliably. Furthermore, it was determined that the TRAP successfully captures all imagery on any given ribbon.

A Blind Study on the Reliability of Hand Printing Identification by Forensic Document Examiners

Linda L. Mitchell, D-ABFDE and Mara Merlino, Ph.D.

Recent court cases involving that hand printing, specifically block letters, have surfaced in the news and among the forensic document examiner community. (United States of America v. Gerald Johnsted, 2013, Florida v. Jesse Lee Miller, 2014) Moreover, the current trend in elementary education is away from cursive instruction so it is likely that printing will become even more commonly used in every day writing. It is very frequently seen in forms, addresses and work-related communications as well. As a result, it has become increasingly important to verify for the purposes of a Daubert Challenge that forensic examination of hand printed documents by qualified Forensic Document Examiners (FDE) is reliable. This study was undertaken in partial response to a court opinion, citing a lack of supporting research in the area of hand printing. It is the purpose of this research to test two hypotheses:

The qualified FDE can very reliably identify block letter hand printing (ALL CAP)

The qualified FDE can do so using the same methods and protocols as in the identification of cursive handwriting.

Each of fifty-three (53) qualified FDE participants was provided with a study packet intended to reflect evidence and procedures similar to normal bench work in a condensed form. Twenty-five (25) questioned writings were offered in individual "case packets." Each case included sample writings of three potential "suspects." Participants were asked to opine (on a nine-point scale) whether or not each suspect was the writer.

The compiled data clearly supports both of the hypotheses; (1) that qualified FDE's reliability rate with only 2.28% of calls inaccurate, when identifying (or excluding) a writer of block hand printing, and (2) that qualified FDE's do so using the same methods and protocols as in the identification of cursive handwriting.

Minimizing Cognitive Bias in Forensic Document Examination

Jane A. Lewis, MFS, D-ABFDE

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Volume 19, Number 2

Sequence Determination in Cases of Non-Intersecting Electrophotographic Print and Handwritten Entries

Martina Lunakova

The article deals with the possibilities of establishing the sequence of handwritten and printed entries in cases with no direct intersection of the two. You can follow the research and development of a method based on direct optical evaluation using a digital microscope with maximum magnification of up to 800x and 2500x, and a method of indirect optical evaluation according to the distribution of toner particles on a sheet of paper using a simple micro zoom camera.

Key words: Sequence of entries, electrophotographic print, handwritten strokes (entries), toner particles, optical method, yellow toner, reflective properties, NIR lighting.

Handwriting Under Acute Inclination on Soft Writing Substrate Versus Tracing Drawn Outlines

John D. Makris.

A Study on the Handwriting of Adolescents in Singapore

Chiew Yung YANG, Chin Chin LIM, Yvonne Hui Ying SIM

The handwriting of adolescents is an interesting and challenging topic. Although a number of similar studies have been conducted in the past, most of these pertain to handwriting in North America and as such, research is limited in Asia. The way handwriting is taught can vary significantly across geographical locations. As shown in the preliminary study conducted in 2014 on the handwriting of 60 students in Secondary 1 (12 to 13 year olds) from a school in Singapore, the writing styles and prominent characteristics of the local population showed differences from those previously reported in other countries. More work has since been done to expand this study to include a greater number of students from three local secondary schools. The results of writing samples from 382 students confirmed that there are a number of differences in the writing styles and characteristics of adolescents between the current Singapore study and previous studies from other countries.

Laypersons' Performance in the Determination of Authorship from a Homogenous Group Of Writers*

Marie E. Durina and Michael P. Caligiuri, Ph.D.

In 2009, the authors reported a study involving 49 FDEs from 5 countries who attempted to determine authorship of writing samples from 52 writers who had grown up in the same neighborhood, attended the same school, and who had all learned to write using the Palmer method. In that initial study, FDEs were able to successfully attribute authorship with average accuracy scores of approximately 98%. A subsequent study was conducted involving a group of 46 Laypersons who were assigned the same comparison tasks as the FDEs involving the same writing specimens. This secondary study compared accuracy and error rates attained by the Laypersons with those attained by the FDEs. Findings demonstrated that the Laypersons in this study were able to determine authorship with average accuracy scores of approximately 76%. A comparison of error rates between the two groups showed an error rate of approximately 39% for the Laypersons Group, compared to approximately 3% for the FDE Group. Additional findings showed there were profound differences between both groups in the number of writing specimens that were problematic for the examiners, and in the strategies they used in examination and comparison of the handwriting samples.

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Preliminary Study on Inkjet Classification Based on Satellite Droplet Distribution

Joerg A. Greis

While there have been several approaches to identify originating printers of questioned documents by the use of texture analysis and pattern recognition most of these articles did not target documents that have been produced by inkjet printers. In this paper a new method for the statistical analysis of the spatial distribution of satellite droplets on inkjet printed documents is presented. The drops are connected to a graph and global graph features are calculated to build a profile vector of the distribution which is then classified. While it turns out that differentiating individual devices is not possible the classification per model yields an accuracy of approximately 84%.

The Preliminary Attempts to Quantify the Three-dimensional Details of Document Surfaces with Reflectance Transformation Imaging

Ning Liu¹, Lichao Zhang²

Reflectance Transformation Imaging (RTI) is a computational photographic method that captures a subject's surface shape details and enables the interactive re-lighting of the subject from any light direction. Multiple rendering modes of this computational photographic method could be very helpful for the analysis of morphological characteristics, among which the normal visualization mode provides the three-dimensional details of the surfaces of documents. However, since there might be visual illusions among different examiners, analyzing three-dimensional details just by observing the normal maps seems incomplete. With the method developed by the authors, the pen pressures of signature samples were experimented on by quantifying the three-dimensional surfaces with the normal data derived from the normal maps. By comparison, the 3D data derived from the normal maps of the signatures were similar to those generated with Confocal Laser Scanning Microscopy. Normal errors were discussed via the quantification method as well. For the inherent error of the RTI technique, the methods of error correction were developed by the authors.

A Study of Photocopier Distortion Through Interactive Animations¹

Robert Gervais²

This paper explores the nature of distortions introduced by the photocopying process. Two types of pens were used to execute both a fast and a slow sample of handwriting. These were then reproduced on photocopiers of various makes and models, both analog and digital. Successive copies were created from each sample, extending twenty generations from the original. The copying process was repeated for each series using the photocopier's light, medium and dark settings. Overall, the combination of writing instrument and speed together with photocopier model and darkness settings yielded eighty-four permutations. The resulting 1680 images (84 permutations x 20 generations) were then integrated into an interactive graphic interface allowing the user to select a set of parameters and explore the distortion, moving back and forth through the twenty generations at will. Trends in the observed distortions were investigated, both at a localized level and across the page as a whole.

Copiers were found to create both distortions (changes in shape and/or size) and image degradation (breakup, thinning, thickening, etc.). The extent of these effects varied between machines and also showed differences across the platen area of single machines (e.g. enlarge in one area while reducing in another). Breakup was found to be more pronounced in areas of the image that are perpendicular to the paper feed direction (i.e. horizontal lines breakup faster than vertical lines when the paper feed direction is along the vertical axis of the page). Given the limited sample size, findings are presented qualitatively, as well as in the graphical interface itself.

The Challenge of Determining the Fraudulent Use of Postage Stamps

Paul Leonard¹

The policing of the worldwide use of postage stamps and items sent through the mail provides many challenges. Not only are millions of stamps used every day, the potential for fraud may take many forms. This technical paper considers primarily historically important philatelic material rather than assessing current counterfeit postage, although the methodology of analysis is similar.

Around the world, there are individuals who will provide certificates that will provide an opinion on whether philatelic items are deemed 'good' or 'bad'. To address this challenge, The Royal Philatelic Society formed an Expert Committee (RPSL) <http://www.rpsl.limited/Home.aspx> that seeks to establish a concluding opinion based on the evidence obtained at that time. This process will follow a series of analytical steps.

The RPSL has extensive museum facilities and over 225,000 records of worldwide significance. Analytical techniques will be used extensively to aid opinions, whether from comparison of reference material, accessing material from other collections such as the British Library or undertaking tests using the Video Spectral Comparator, VSC6000 manufactured by Foster Freeman <http://www.fosterfreeman.com/questioned-document-examination/vsc6000-hs-col-180-comprehensive-examination-system.html>. This equipment has enabled comparison with previously published information and assessment of whether there are printing differences of philatelic material. Future work is likely to include international collaboration with other scientists, comparing analytical techniques on a weight of evidence approach to conclude with an opinion. Specifically on whether items are fakes, for example where a philatelic item has been manufactured to deceive the purchaser, forgeries where part of a stamp or envelope has been changed or in all aspects is considered genuine.

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Kinematic Models of Subjective Complexity in Handwritten Signatures

Miriam Angel, Michael P. Caligiuri, Ph.D., Melvin Cavanaugh

This research seeks to develop a model using kinematic features that best explains variability in Forensic Document Examiner's (FDE's) perception of complexity. One hundred and twenty-three individuals provided five genuine signatures each. All signatures were collected on a tablet running MovAlyzeR® software, which recorded the kinematic data while the subject was signing. Scanned copies of the signatures were sent to five FDEs who were asked to rate the complexity on a five-point scale. For the purpose of this study, complexity was defined as how difficult it would be to simulate the signature without detection by an FDE. The effects of signature style on stroke kinematics were statistically significant for several variables, so separate models were developed for the three signature styles. Kinematic models ranging from three to eight parameters explained 71%, 76%, and 79% of the variation in complexity judgment for text-based, stylized, and mixed-style signatures, respectively. Our results confirm those from previous work that the number of strokes (or the number of turning points) in a signature is a strong predictor of FDE complexity assessment, adding that other kinematic variables such as stroke velocity, slant, horizontal stroke length, and total length of all segments of the signature, together with number of strokes, account for a greater portion of variability in complexity perception. These results underscore the importance of sensitive kinematic analyses of temporal and spatial features in understanding signature complexity.

Dating Water-Based Inks on Documents—Rollerball Pen Inks Containing Pyrrolidone

Valery N. Aginsky, PhD.

The ink aging methodology that is based on measuring a gradual loss (due to evaporation and diffusion into paper) of high boiling solvents from ink on paper has been extensively published and its capabilities, limitations, and scope of applicability discussed in scientific literature. This paper describes an application of this ink aging methodology to the dating of the rollerball inks that contain the high boiling solvent 2-pyrrolidone (2-PD). This work is a continuation of multiple published works that studied natural aging on paper of both oil/glycol-based inks (conventional ballpoint inks) and water-based inks (rollerball and gel ballpoint pen, felt tip pen, stamp pad, and inkjet inks). The goal of this work was to study the natural aging of rollerball inks on paper by monitoring a gradual loss of 2-PD—a high boiling solvent that is used, along with water, for manufacturing Pilot® rollerball pen and other water-based inks. The results of this work show that, at normal environmental conditions, the rate of the loss of the solvent 2-PD from inks after their placement on paper, as well as from paper in close proximity (immediately next) to the inks' strokes, may correlate with the age of the inks during up to 12 months following the application of the inks to paper (the natural aging curves "Content of 2-PD—Age of Ink" obtained for the inks tested in this study leveled off within less than 6 months, when single ink lines were tested, and within less than 12 months, when 'thick' layers of ink on paper, such as the areas of retracing and intersection of two ink lines were tested). It is important to note that the ink-aging analysis of the ink in the areas of retracing and intersection of two ink lines is only applicable for certain types of water-based inks, such as rollerball inks, that produce ink strokes homogeneously filled with ink within the confines of ink lines. Thus, a monitoring of the gradual loss (with age) of 2-PD both from 'thick' lines of inks on paper and from paper in close proximity to the inks' lines allows one to distinguish between fresh (less than 12 months old) and old (significantly older than one year) entries written with rollerball inks.

Utilizing Data From Write-On™ 2.0 To Provide A Stronger Scientific Basis For Handwriting Examinations

Chris Anderson, Anna Agius and Gary Storey

Forensic document examination can fall prey to criticism regarding the lack of a proper statistical basis in handwriting examinations. The development of Write-On™ as a tool to aid forensic document examiners (FDE's) in the analysis of handwriting has helped to address this situation. One facet Write-On™ provides is a wealth of statistical data, however it seems to be largely under-utilized. The authors have developed methods to better exploit the statistical data produced by Write-On™, which gives the examination a stronger scientific footing. This research explores how to extract the data produced by Write-On™, export it into Microsoft Excel® (Excel) and use the data to demonstrate whether there is a sufficient quality and quantity of handwriting to conduct a proper and adequate comparison. Conveying this information in a report provides an improved scientific basis for the opinion expressed.

A preliminary study of 3D depth measurement of the grooves generated by three different pens for handwriting

Francesco Dellavalle and Sergio Frontini

In order to produce a handwritten graphic trace, contact between the tip of the writing instrument and the writing medium is required. The pressure of the pen tip on the paper is necessary to ensure that there is a transfer of ink on paper, depending upon the writing instrument, the paper, the writing surface, and the author's habit, more or less pressure will be exerted when this contact is made.

In the field of forensics, the effort exerted by the writing hand is evaluated by the intensity perceived in the color and amplitude of the graphic pattern, over the depth of the groove visible on the back of the sheet.

The inking of the stroke might not be directly correlated with the degree of indentation in the paper.

For example, it may happen that the inking of the stroke is not directly correlated with the level of depth of the groove in the paper, therefore could be due to defects of the graphic medium dispensing, or by the speed of the movement of the hand of the writer.

The measure of the depth of a writing groove and the measure of the relative pressure variation along a graphic pattern may constitute an important fact for the forensic examination of documents.

The subject of this article is therefore a first metrological approach that aims to quantitatively define for any given "writing means" (i.e., pens) and "writing medium" (inks):

1. the differences in degree of indentation for the same individual;
2. the differences in degree of indentation, if any, for different individuals;
3. the absolute limits that the degree of indentation can vary continuously.

ABSTRACTS

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Kinematic Validation of FDE Determinations about Writership in Handwriting Examination: A Preliminary Study

Michael Caligiuri, Linton Mohammed, Brenda Lanners, and Gina Hunter

As with many of the forensic disciplines that rely on feature-comparison methods, there is no “gold standard” against which to test accuracy of handwriting examination. This study examined differences in kinematic features between pairs of handwriting exemplars judged to be from the same writer and compared them with differences in kinematic features for pairs of handwriting exemplars judged to be from different writers. We hypothesized that differences in kinematic features between pairs of handwriting exemplars judged to be from the same writer would be nonsignificant; whereas differences in kinematic features for pairs of handwriting exemplars judged to be from different writers would be statistically significant. Cursive, script and block print handwriting samples were obtained from 37 writers who were asked to write a single word ten times each. High resolution (600 ppi) scanned copies of the original ink and paper samples were submitted to four experienced forensic document examiners (FDEs) for writership determinations. Each score sheet included 5 known (K) handwritten samples and two questioned samples (Q1 and Q2). FDEs were asked to rate the evidence in support for the proposition that the Q samples were written by the K writer using a 4-point scale (ranging from limited or weak support to very strong support for the proposition). Kinematic difference scores derived from dynamic analysis of the handwritten strokes were converted to absolute standardized z-scores with larger z-score reflecting greater differences between K and Q for a given kinematic feature. Findings revealed that several kinematic handwriting features were significantly associated with accurate FDE opinions of acceptance and rejection of the proposition. Significant features included pen pressure, stroke velocity, and straightness variability. Correlational analyses revealed strong associations between specific dynamically recorded stroke features and FDE judgments of writership; particularly for pen pressure and straightness. Results support the use of an independent quantitative measure of feature comparison as a tool for evaluating the foundational validity of subjective feature comparison methods experts use when reaching conclusions about writership.

Global Review of Questioned Document Laboratories in the 21st Century

Sharon Brown, Geulit Anavi and Batya Fuchs

In light of the constant advancements in new technologies for the production and examination of authentic, forged and counterfeit documents, an interest was expressed to determine which capabilities, working methods and instrumentation are used in questioned document (QD) laboratories.

Survey answers were collected from recognized document examiners around the world.

The collected information demonstrated that document examination is relatively consistent across the globe. Furthermore, it may be utilized to suggest guidelines for a “best practice” setup for a QD laboratory.

The smaller number of labs currently working in areas such as chemical testing of printing inks and dating of ballpoint inks may encourage other QD laboratories to consider new instrumentation or examination methods.

Book Review: *Huber and Headrick's Handwriting Identification: Facts and Fundamentals, Second Edition*

Charles L. Eggleston

Harralson, H. and Miller, L. (2018) *Huber and Headrick's Handwriting Identification: Facts and Fundamentals, Second Edition*. CRC Press, Boca Raton, Florida, ISBN 9781498751308, 420 pages, \$99.95.

Understanding Sinosphere Characters through a Comparison of Korean, Chinese, and English Characters

Jinwoo Choi, Mijung Choi and Chris Anderson

Since ancient times, the application of Chinese characters went beyond China's borders to regions such as the Korean peninsula, the Japanese archipelago, and northern Vietnam; their use was a necessary means of educating intellectuals and sharing culture. The Korean alphabet, known as Hangul in South Korea, was created by King Sejong the Great in 1446 and employs phonograms that give the sound of characters by combining graphemes, as in English. However, while there is a morphological difference of linguistics compared to Chinese characters (i.e., ideograms), one principle of the Korean alphabet established during its inception was that it should be used in combination with Chinese characters. Therefore, the Korean alphabet naturally absorbed intrinsic denominators such as syllable-based writing in a square frame and vertical writing. This common denominator contrasts the phoneme-based horizontal writing of English in that the graphemes, radicals (i.e., bushu), and basic characters are arranged within the limited range of the square frame. In such a system, the size, slant, proportion, and arrangement of the graphemes and radicals mutually affect each other in the writing process at a level above the word impulse. Based on the basic structure of the Korean alphabet, this paper focuses on understanding the differences between the Korean, Chinese, and English characters, as well as the correlations between square frame structure and vertical writing, which are an intrinsic feature of Sinosphere³ characters. Accelerated globalization requires Forensic Document Examiners (FDE) to better understand these various characters and their correlations with English characters plus gain an understanding of the Korean and Chinese cultures they came from. Therefore, this paper examines the square-framed, syllable-based writing form, as well as the vertical writing system with regards to handwriting analysis in forensic document examination.

Classification and Ink-Dating of Inkjet Printed Documents with TDS-GC-MS

V. von der Kall, J. Schram, T. Rottes, D. Bogedain

In document examination casework, the need for a method to differentiate pigmented black inkjet inks and determining their age increases. More and more documents are produced using the inkjet print technique. Commonly this raises questions for the examiner concerning the machines used to produce the documents and the age of the prints.

The first part of this preliminary study aims to distinguish different inkjet inks (printed on paper) by analyzing their main volatile components and assigning them according to their composition. In the second step of the research, it will be assessed whether it is possible to date these inks by measuring the decrease of volatile ink components (e.g. 2-Pyrrolidone, TEGBE) as a function of time.

Initials Value For Identification

Jane A. Lewis

This study was conducted to determine the individuality of handwritten initials and their similarities and differences when compared to the capital letters representing the first letter of each name in a signature. Initials and signature samples were collected from 456 people in order to answer 8 research questions. The main research question asked whether one or more initials were constructed similarly to the capital letters in each person's signature. Evaluation of the collected forms recording the initials and signatures showed the individuality of many of the letter construction of initials in cursive and hand printed styles. The study aimed to provide an evaluation of modern initials, their general format and individuality. Initials were found to conform closely to capital letters in the majority of examples examined; however, they also diverged in a smaller group of initials. The initials complexity ultimately determined the individuality of initials in this study.