



## Forensics Analysis of Typewriter and Typewritten Documents

Fatima Fatima  
fatima.dfrsc@lgu.edu.pk  
Lahore Garrison University

### Abstract:

This article reviews the forensic examination of the typewriter and typewritten documents. The main purpose of examination is to identify the source or origin of the typewritten documents or the link between two typescripts that can be vital to a court of law. Immense application of the typewriter increased the production of fraudulent documents for deceit. Typewritten documents are examined using scientific methods based on class and individual characteristics. These are physical and chemical methods of observation and comparison.

### 1. Introduction

The beauty of letters written on a paper fascinates the attention of the reader particularly in case of scripts produced by the electronic typewriter in offices and institutions (5). There are various typed and office printed documents which have been produced in different forms for a significant time period. The first typewriter introduced commercially was as long as 1873 which further made the introduction of electronic typewriters. It was followed by the development of computers and printers as advances were made in technology. Large application of these devices in workplace and home increased the production of fraudulent documents greatly over the years (1,2).

Typewriters are being frequently used to write threatening letters, ransom and extortion notes for criminal objectives. It is mistakenly considered by criminals that the impressions produced make the letters or notes imperceptible. It is not only true in case of pen and paper that leave traces behind about the source of a document but also mechanical devices do so. Typed or copied documents can have distinctive marks often left by typewriters, printers and copy machines. These marks can help the investigator to reveal any alteration in document or the exact machine that produced the document in question. In case of typewriter,

the document examiner finds out the make and model number, compares the typed note with a suspect typewriter for the match/mismatch if available (4).

The information obtained from the forensic document examination can be presented to a court of law or to investigating police officer that seeks evidence relevant to the source or origin of questioned document. These information can be conveyed in different ways including obvious typed or printed words or marks in a script and other elusive hidden marks that cannot be seen with naked eyes such as misalignment of characters, microscopic damage to typeface of a typewriter, security or water or pressure marks exerted during typing to hold the paper mechanically in a typewriter or printer. By concentrating on such information, document examiner can determine the forgery. Although there are many cases where evident falsification can immediately be seen such as one of document relevant to attempted suspicious purchase of Uranium in Iraq by the Saddam Hussain Government from Niger where an outdated letterhead was typed with incorrect symbol of Niger presidency (1).

For the admissibility and validation of typewritten evidence to a court of law, proper documentation must be followed for document examination that can be obtained by following

country or state's administrative protocols and scientific procedures (1, 2).

## **2. Typewriting**

Typewriters have now been used for more than 100 years with modification in form and manufacture standards. Initial experimentation evolved a standard typebar machine, is still found in use today. Beside these simple and basic models, more advanced and different forms of typewriters have been introduced into the industry of which some have become outdated (2, 3). Typewriters are of two types, a typebar typewriter and the interchangeable single element typewriter. The typebar typewriters have typeface element that is fastened into the machine permanently whereas the interchangeable element typewriters have typeface that is fixed to a type ball, printwheel or thimble that can be exchanged and removed easily from the machine (1, 13). Of such single element typebar machines unfortunately are replaced now by computers which are connected to printers that use daisy-wheel, dot-matrix, and ink-jet or laser technologies. These have provided a variety of means to printed characters on documents involved in criminal activity. Over and above the content typed can provide evidence of worth to the investigator or court (2, 3 & 4). The document examiners when handling typewritten questioned document, look at typeface and letter spacing of the machine or typebar element as follows(1, 6);

### **2.1. Typeface**

Typewriter manufacturer adopted a general style of typeface for many years following with differences in size and design. Some of makers can have fairly large differences in their products, and some with more understated. Larger differences or variations are of numerals including figures such as 2s with or without straight bases, 3s with curved or flat tops, and 4s either with an open or enclosed triangle. Capital letters are also of larger variations such as M and W are made to type with center either extending to the whole or half of the height of letter. Smaller variations are found in lowercase letters such as the letter a shape at bottom and letter t with cross bar position and length. Each style differs radically like those of shaded characters with differences in line width, making the letter "cubic", rectangular designs with rounded

corners rather than circular, and designs similar to cursive handwriting (2, 3 & 8).

All these designs can be moved manually or electrically after mounting on typebars or single elements typically called as "golf ball" or "daisywheels" because of the appearance. They are easily removed and replaced by other styles from a machine. Earlier, these typefaces were designed and made for the machine by the manufacturer but now supplied by specialist producers for typewriter manufacturer. Document examiners should have a collection of typefaces of different machines with classification system that can enable them to find out the style that resembles the typewriting found on the questioned document. The collection is also used for the identification of common origin when comparing typewriting from questioned and known document (2, 3 & 7).

### **2.2. Letter Spacing**

The typewriters involve a mechanism that is used to ensure proper spacing of the letters. Most collective spacing is 10 to 12 letters to an inch of typewriting. Commonly, document examiners do not refer to spacing characters per inch, rather length covered by 100 characters. Therefore, typewriters that print 10 characters to the inch with spacing of 254mm per 100 characters are known as pica machines. While those that print 12 characters to the inch with spacing of 212mm per 100 characters are referred to as elite machines. Other letter spacing used by manual, electrical typebar and single element machines are of 185, 200, 210, 220, 225, 230, 236, 250 and 260 (1, 2 & 3). Proportionate letter spacing is obtained by machines that print letters based on units depending on their width. Typical units are 1/32 or 1/36 of an inch with result nearly similar to pica and elite spacing (2, 3, 7 & 14).

## **3. Typewriting Identification**

Typewritten documents can be examined by using the scientific principles of observation, reasoning with appropriate tests and comparison with known reference standards. The main task of the examiner is to determine the similarities or differences between the two pieces of typescripts. At first, the examiner will identify the source of production of the disputed document either it was typed on a manual typebar machine, single element or produced by

ink-jet or laser printer (1). Secondly, the document examiner will identify the manufacturer, model of the machine, a particular machine that was used for alteration and addition to a document other than that was used to type original document, date of the document typed at, and the manufacturer year of the typewriter or in some cases ink or paper (1, 2 & 3).

Typewritten documents can be simplified both as class and individual characteristics. Class characteristics include those of specific make and model number of machine, identified by comparing the typefaces with a reference collection such as Haas Atlas. It is now in the form of computer database program which contains the images of the typefaces with reference to typewriter make, name, manufacturer and serial number (1, 2, 4 & 18). While individual characteristics involve the comparison of a questioned document to a particular typewriter machine. Such characteristics are developed through use and misuse of the machine in the form of wear on a character and faulty alignment. Such evidence linked to a specific typewriter was found in USA Unabomb case of 1998 conviction of Theodore J. Kaczynski (1, 20) known as the Unabomber in which a unique characteristic of the letter "u" was identified from the correspondence from Kaczynski that matched the letter "u" on a typewriter key seized during investigation. Individual characteristics can be attributed to a particular machine if it is a typebar machine whereas machine with an interchangeable element, only a text can be associated with a particular element rather than a machine (1, 2, 4 & 9).

The main approach of the document examiner in most of the examination for efficient identification is the comparison of questioned document with known or standard documents rather than those of individual characteristics. This is observed due to a wide variety of characters, word spacing and page styles all on the same printer produced by word processing software (1, 2 & 3). According to Ellen David, many typewriter manufacturers have merged and been producing particular typeface or letter spacing that may not be peculiar to one make and model of machine. Therefore it is possible for a machine to produce different results for various reasons such as changing of the print element in

interchangeable element machine while many electronic typewriters can also produce typed documents at two or different spacing (1, 7 & 10).

### 3.1. Comparison of Typescripts

The comparison of the typescripts is similar to that of handwriting analysis where the two documents are observed side by side, noting each letter, figure, comma, question mark, currency sign, and other considerable characters if they match. Obvious signs of imperfections caused by damage or clear misalignment are noted and compared. The whole depiction of important features, similarities and differences or variable, is evaluated to reach a conclusion. In most of the comparison cases, the variation within the sample is relatively considerable that can be caused due to number of reasons such as looseness in mechanism of the typewriter, quality of ribbon, and features associated to the typist. Features obtained from side by side comparison are sufficient enough to arrive at any proper conclusions (1, 2, 3 & 10).

The significant points for the comparison of the typescript are the overall size and design of the typeface letters and numerals such as capital M and W, the figure 2 with or without straight base, and curve at the ending of letters like f or t (1, 6). Spacing and size of letters were fundamentals of the document examination such as in case of Killian documents dispute where the allegedly forged documents were brought to public notice during the US presidential campaign of George W. Bush in 2004. Two document examiners, Richard Polt and Flounder came to conclusion that was based partly on letter spacing. Results concluded that the Killian documents presented could matched the modern technology based computer and printer using Microsoft Word with default font. These documents were allegedly typed in 1973 when the proportional print typewriters were in use while the original documents were produced on a typewriter with differential spacing and straight apostrophes. The forged documents produced were with proportional spacing and curly apostrophes which can be achieved on a computer (1).

### 3.2. Image Comparison

At early days, type scripts were examined by comparing them with known or standard

typeface specimens printed on cards which were projected onto a large screen and sent to another computer for analysis. A modified examination if necessary, can be performed by using the specialist spacing grids in the form of plastic sheets marked with regular spaced vertical lines especially designed to fit the spacing selected by typewriter manufacturer. The relative position of the grid lines when placed over the typed character, gives a clear clue of accuracy of its alignment (1, 2, 3 & 6).

Other than grids, high resolution imaging software can be used for comparison that produces direct superimposition of images with differences among them. Traditionally, it was done optically by using comparison projectors such as Docucenter 4500 that project the two document images together onto one. The two documents when superposed appear to be one if they are same. The differences in the two documents can be seen by oscillating the images or lightening the documents with different colors such as red and green. Even smaller differences produced from different typewriters can also be detected by contrasting smaller variations found in the output of one machine such as alignment, wear or damage (2, 3).

### 3.3. Typewriting Dating

A typed document can be dated by using features which are present in one sample but absent in other. Most of the time, a document is questioned to establish certain time period when it was typed such as combat report in 1942 by Lieutenant Marseille, a German fighter pilot during world war II known as "Star of Africa" on the battlefields of northern Africa. The authentic report dated 27.2.1942 has been written on a German typewriter likely Triumph having typeface amongst the old type models with closed middle element "M and W" as shown in



Figure 1: Authentic report by Lieutenant Marseille from 1942 (19).

This typewriter was manufactured between 1930 and 1940, and equipped with the Pica type font "Ro 1" whose earlier version started in 1964 (2, 3 & 19). The type font produced by "Ransmayer & Rodrian" in Berlin, contains following new types;

- " M W " characters with shortened middle element was produced in 1951.
- " f " character was produced with shortened horizontal middle line in 1957.
- " r " character was produced with horizontal line lengthened on the right side in 1961.
- " i " character was produced with shortened horizontal headline in 1964.

Therefore, the results obtained from the examination of falsified or questioned combat report are contrary to the date 27.2.1942 as it contained the characteristic features which were not introduced in typed year of the report as shown in following figure (19);

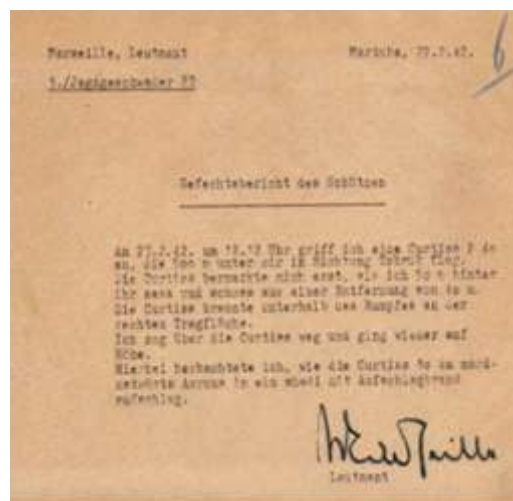


Figure 2: Falsified combat report Lieutenant Marseille from 1942 (19).

The samples of the output of a machine produced at a regular interval, can be examined by discovering the old and new occurrence of the damaged characters with changing pattern of faults. Like from noting the fault found in a certain document but not another then the time period during which fault existed can be discovered by the analysis of sequence of dated documents. Features other than fault or damage to a typewriter, after repairing can also be used to give information about the date of typing (2, 3 & 11).

#### 4. Linking Typewriting to a Typewriter

Substantial evidence other than deduced from typescript, is the actual machine identification that was used to type it. It is used as a significant evidence in the investigation of a trial in civil or criminal court. It is not always the case to compare the typewriting with typewriting, instead quick comparison of typescript with typeface on the machine is made. Exclusion or inclusion of the typewriter or typeface element is made if clear differences are found after comparison such as a round top 3 on a document and flat-topped 3 on the machine. Sample is taken out for more detailed comparison if such difference is not seen (2, 3).

During the comparison of typescript with typewriter, the typeface in the typebar machine and the typewriter its self are to be regarded as one such as in single element models either type ball or type wheel, the typed material has both a machine and an element in a combination of two. It is not found in practice for the typewriters to be set to a standard of absolute perfection by limiting the value of results obtained from the comparison of their products. Therefore, variations can be found in the typebar machines, type elements and mechanism of typewriters using those elements (2, 3 & 7). Difference found after maintaining quality control is small to be of forensic value. One source within forensic science, produces variability when compared. If such variation of significance found between the sources, no key comparison can be placed. Small variations found between typewritings produced from different machines are no larger than those from one machine. Features that develop during lifetime of a typewriter such as fault from wear or damage, are of greater significance as these occur randomly for the most part. These features are different for different typewriters as follow (2, 3 & 9);

##### 4.1. Mechanical Faults

Visible imperfections in the typescript can occur in a number of ways such as damage to individual characters and misalignment of certain characters. The damage can be in the form of bent or chipping of the metal type due to the depression of two keys of the typebar machine together and collision between the two components, showing results in subsequent

printed impressions. Type ball machines have less dominant damage due to small molding defects during manufacture that can be appeared on a typewritten page. However, print wheel characters are also susceptible to mechanical fault. The damage in the metal type of the type bar machine remains unchanged permanently while the damage in the plastic material of type wheel elements deteriorates quickly once the coating surface has been broken (2, 3 & 7).

Misalignment of certain characters can occur during manufacturing of metal type pieces bearing characters which are fused onto the ends of the type bars. The consistency applied for affixing them is not always perfect, resulting in small differences in the relative positions of the printed characters. The twist or bent in a type bar, will result in misplaced impressions of the characters diverging upward, downward, left or right, at an angle or combination of two or more from their ideal positions. Depending on the distortion of the type bar, twisting can result in an uneven image by printing character more heavily on one side than other or at top or bottom. Looseness can occur during mechanical process which can produce characters with aligned or out of their positions. No constant misalignment of a single character can be revealed if there is great variation in the relative positions of all the keys (2, 3 & 10).

The rotating mechanism in the type ball machines, can print characters out of adjustments due to wear or damage resulting in misplacement of characters on the row or column. As it is a mechanical fault of the machine so it will be present though the type ball is changed. Damage to the base of the element which is to position it mechanically, can also misplace a vertical row of characters. As this fault is in element then it can be disappeared if the element is changed and when the same element is placed in another machine, same defect will be appeared again (2, 3 & 7).

Print wheel machines unlike conventional type bar machines, also give displacement of the printed characters but with one character position only due to the distortion to the type bar of the wheel. The spacing of daisy wheel machines is very consistent varying between machines. The causes of variation could be both in the machines and element (2, 7 & 15).

## 4.2. Other Faults

There are various other reasons that can produce less than imperfect results from the typewrites as follow;

- Dirty characters can misprint a letter such as an unlinked circle printed as a solid one. This can be corrected easily as it is a temporary condition.
- Mechanism of the shift key can move too far or not that results in capital letters and position higher or lower than they should be.
- Loose paper holding mechanism may result into unevenly separated lines of the typescripts.
- Disposition of the platen or flat metal plate can cause all the characters to print heavily at the top or bottom.
- Spacing mechanism of the platen sometimes can misfire or backfire by giving unrequired gap between characters or crowding of two letters on each other.
- In electric type bar machines, the pressure adjustment for each character is different so printing constantly more heavily or lightly.
- Defective alignment of the ribbon in the typewriter can cut off the top or bottom of the characters. Similarly, mixture of black and red typescript is print out if dual color ribbon is used (2, 3 & 8).

## 5. Sample Collection

The role of forensic investigator in comparison of typescript is either to identify the source or origin of a document or the link between the two or more typewritten documents. In most of the cases, the typewriter acquisition as an evidence is a lead for various reasons such as discovering of characters which appear on the typescript but not in the typeface of the typewriter. This points out a possible source if the key of relative character is not replaced or it is damaged that can be seen upon examination of the machine (2, 3). Recovery of ribbon, correcting tapes and electronic memories as evidence from the machine can be dealt later for the comparison to the typewriter rather than samples from it. Extra element is taken with the machine if it is acquisition of single element machine (2, 3 & 9). When it is not possible to remove the machine, then samples should be taken either by using a ribbon or a piece of carbon paper with control of ribbon in template position. It may provide better results if the carbon paper is new or ribbon

is in good condition. In some cases, it can produce so thick lines limiting the details if heavily inked fabric ribbon is substituted but satisfactory for carbon paper as it gives clearer outline of the characters (2, 3 & 8). Samples of entire keyboard both with and without operation of shift key, should be taken to record all the features of the characters including upper lowercase letters, figures, and punctuation marks etc. While taking the samples, the question passage should be typed four to five times in same layout as that of being compared so that the output consistency can be tested. Machines collected, should be identified with details such as make, model and serial number. Possible valuable evidence can be obtained from the known materials that have been typed on the same machine being questioned when there has been a change over a period. When the date of the typewritten document is questioned, the letters typed on or around, before and after this date are significant. If a typewritten document has more than one possible sources, document examiner may make a primary examination of obvious features such as center of capital Ms and Ws, straight or round tape of figure 3 and open or close end of figure 4. The typeface in the typewriter machines as compared to the modern machines, is fixed, therefore a mismatch likely indicates that different machines or different elements have been used (2, 3 & 9).

## 6. Other Examination Process

There are various means of connecting a typescript with a typewriter other than comparison of typescript. Most significant of these are the examination of the ribbon, ink analysis, identification of erasures or addition and who typed it as explained following (2, 3);

### 6.1. Ribbon-Composition Identification

Identification and examination of typewriter ribbon is essential for a typewritten document if suspected as altered or added. These are temporary equipment which do not need identical replacement therefore stating that difference in the ink of the ribbon in a machine and on the paper, does not exclude the typewriter machine from the one used to type that particular typescript. As the ribbons are made in large numbers to a controlled standards so it is of little worth to compare the ink or plastic material on the typewritten paper with other document or in

a ribbon of a typewriter. However this is useful to compare two typescripts that might have been typed approximately at the same time on the same machine (2, 22).

There are two basic types of typewriter ribbon, the fabric and carbon ribbon. The fabric ribbon uses ink and does not retain legible image of the prepared text whereas the carbon ribbon can retain readable text by using carbon film. Both of the types can be distinguished clearly under low-power magnification. Other types are correction ribbon including lift off and cover up which also retain images that can be compared with text and carbon ribbons (21, 22 & 23).

Carbon ribbons are produced by a number of different manufacturer that can be distinguished on paper by microscope. Comparison of paper fiber-transfer is possible by using comparison microscope as the polythene backing on carbon ribbon with low density can assume the imprint of fibers in the paper. Scanning electron microscope (SEM) is used for the sequencing of typing stroke order determination of the fabric ribbons and deposits from the carbon ribbon. In case of typing which crosses a signature made with ball point pen, can determine the stroke order from the carbon ribbons. Scanning electron microscope analysis gives clear separation of different types but being partially destructive method as piece of questioned document is removed, is a drawback though recent development made it possible to enlarge specimen chamber (12, 22).

## **6.2. Ink Identification**

Ink and paper analysis sometimes can determine the age of the production of typed document by working on dating of inks production and composition. Document examiners try to determine as much information as possible from typescript by using nondestructive techniques of observation and comparison with naked eye, magnifying glass and optical techniques such as Video Spectral Comparator (VSC), Ultraviolet light UV and Infrared IR. However in some cases, these methods become insufficient for the identification of the ink used to type the questioned document so therefore chemical methods are applied which can cause partial destruction of the document such as Thin Layer Chromatography (TLC), High Performance

Liquid Chromatography (HPLC), Capillary Electrophoresis (CE) and Gas Chromatography. Ink libraries are being developed yet with limited samples (5, 17 & 24).

## **6.3. Typewriting Erasures Identification**

Typewriting documents can be subjected to alteration by using special correcting fluids which is normally used for the correction of typing mistakes. This can be identified by using strong lighting source directly on the page or through the page from the back side as the paper of the typed document is likely to be thinner than the layer of dried correcting fluid. Suitable inert volatile liquid is used that soaks into the paper and correcting fluid by making it more translucent and does not affect the typewriting. As the solvent is volatile so the examination and photograph must be made quickly. The procedure can be repeated as it does not affect the paper permanently (2, 4 & 11).

Mechanical means are also used for erasing the typewriting using sharp blade for scraping the surface or hard rubber to erase. Oblique lights are used for identification of what was erased by examining indentations and traces of ink remaining. Infrared (IR) light is used for identification of erased typewriting where an invisible component of the ink that penetrates more deeply into the paper, may luminesces in this spectrum. However, typewriting produced with carbon ribbon adhere only to the surface of the paper which can be easily lifted off with an inbuilt adhesive tape and their remained indentation can identify the erased typing (2, 12 & 16).

## **6.4. Added Typescript Identification**

Alignment consistency testing can determine the timing of the two pieces of typewriting on the same document or paper. It is assumed for the cases where the piece of typewriting on a document was not present when it was seen first or when it was signed or added later for the deceiving objectives. For the purpose to add an extra typewriting to an already typed document, it has to be replaced in the machine with accurate alignment both horizontally and vertically. It is not easy as it sounds to ensure the exact alignment of the added portion in a correct position.

Gird method is helpful for the examination of this typewritten evidence. Grid covers the main body of the typescript so that each character on a line is in position in its box and centrally placed. Only alternate lines will be positioned accurately if half spacing is applied while the other lines will fall into place. This method shows either characters fall into the correct place or not in the grid. Any crease or fold in the typewritten document can cause problems as it reduces the length of the paper sheet and appearance out of alignment. It should be considered before making any conclusion (2, 3 & 7).

### 6.5. Typist Identification

There are different typing methods developed by technical changes in fashion or styles, apply individuality to the basic pattern. Therefore, a letter can be typed in number of ways causing variations such as spacing of lines, size of the margins, and indentation depth at the beginning of paragraph, number of spaces after commas or periods, and use of capital letters (2, 3 & 10). All of these variables are consistent for one typist. Typewriting in questioned made with manual machine, can give the touch of the typist which is an indication of who typed it. It is helpful in exceptional cases where heavy pressure is applied even though sometimes the periods and letters are punched out of the paper. All of these factors are not unique and can be relevant to the operator how he/she was taught. Like a person with no proper training of laying out a letter is unable to create a well-produced piece of typescript as compared to a professional typist (2,3).

The common authorship of two pieces of typewriting can be obtained by the identification of the errors made in them such as infrequent typist may have problem with figure 1 who is quite likely to use capital I. This evidence can be sufficient in a limited population where to pinpoint only one or two people for a particular style of typing. It is also possible for a person to mask his ability by copying errors of another person therefore considering all possibilities. Identification of typist can be made by the comparison of known and questioned document using previously typed material by the suspect (2, 3 & 10).

## 7. Conclusion

Typewritten document is one of the class of questioned document examination that always has been needing solution. Careful observation and comparison is made for the examination of typescripts produced on a typewriter. The charge of document examiners is to discover either two or more pieces of the typescripts are similar or there are clear differences. If they have differences then it is indication of two different source and if these characters are found to be similar in two typescripts, then they are concluded to have a common source of production or one machine has been used. Class and individual characteristics are used for the comparison of typescripts and a typewriting machine. Scientific methods of examination by physical or chemical means are performed for comparisons. Some of these methods can be destructive but advances in science reduced the chances. Careful observation must be made before reaching any conclusion.

## 8. References

1. D. Catalin, "Forensic Examination of Typewritten and Office Printed Document," International Journal of Criminal Investigation, vol. 1(1), pp. 11-16.
2. E. David, "Scientific Examination of Documents," Taylor & Francis Group, 4th Ed, 2018.
3. E. David, "Scientific Examination of Documents," Taylor & Francis Group, 2nd Ed, 2003.
4. P.L. Douglas, "Forensic Document Examines Dissect Typewriters & Photocopiers," Dummies; A Wiley Brand. A v a i l a b l e : <https://www.dummies.com/education/science/forensics/how-forensics-document-examines-dissect-typewriters-and-photocopiers/>
5. K.M. Varshney et al., "Ink analysis from typed script of electronic typewriters by high performance thin layer chromatography," Forensic Science International, 72th Ed, pp. 107-115, 1995.
6. E.B. Peter, "Image Processing of Forensic Documents," University of Mannheim, Germany, 1995.
7. O. Hilton, "Problems in Identifying Work

- from Print Wheel Typewriters," *Forensic Science International*, 30th Ed, pp. 53-63, 1986.
8. O. Hilton, "Identification of Typewriting. Problems Encountered with Shaded and Proportional Spacing Type Faces," *The Journal of Criminal Law, Criminology, and Police Science*, Vol. 48(2), pp. 219-223, 1957.
9. W. Colleen, "Hand Book of Forensic Services," *Federal Bureau of Investigation*, 2003.
10. O. Hilton, "The Influence of Variation of Typewriting Identification," *J. Crim. L. & Criminology*, vol. 50, pp. 1959-1960, 1957.
11. O. Hilton, "The Complexities of Identifying the Modern Typewriter," *Journal of Forensic Sciences*, Vol. 17(4), pp. 579-585, 1972.
12. W.L. Leaver, "Introduction to Forensic Document Examination," *The Forensic Laboratory Handbook: Procedures and Practice*, pp. 223-248.
13. Borashin, "Typewriter Forensic Identification," *New Modes of Reading and Writing*, 2011. Available: <https://newmodes2011.wordpress.com/2011/02/03/typewriter-forensic-identification/>
14. O. Hilton, "Test Plate for Proportional Spacing Typewriter Examination," *47 J. Crim. L. Criminology & Police Sci.*, vol. 47(2), pp. 1956-1957, 1956.
15. M.A. Lamar, "An Analysis of the Identification Value of Defects in IBM Selectric® Typewriters," *Journal of Forensic Sciences*, Vol. 29(2), pp. 624-627, 1984.
16. J.A. Lewis, "Forensic Document Examination; Fundamentals and Current Trends," *Academic Press is an imprint of Elsevier*, 2014.
17. L.C. Bate et al, "Application of Activation Analysis to Forensic Science: Physical Evidence," *International Journal of Applied Radiation and Isotopes*, vol. 14, pp. 549-556, 1963.
18. D.A. Crown, "Class Characteristics of Foreign Typewriters and Typefaces," *J. Crim. L. Criminology & Police Sci.*, vol. 59(2), pp. 298-323, 1968.
19. Bernhard Haas, "Typewriting Cases," *Forensic Document Examiner*, Winnenden, Germany, 2019. Available: <http://schriftexperte.de/en/cases/>
20. E.H. Dorothy-Anne, "Handwriting, Typewriting, Shoeprints, and Tire Treads," *FBI Laboratory's questioned Documents Unit*, vol. 3(2), 2011. Available: <https://archives.fbi.gov/archives/aboutus/lab/forensicsciencecommunications/fsc/april2001/held.htm>
21. M. Jacques and P. Roman, "The Examination of Typewriter Correctable Carbon Film Ribbons," *Forensic Science International*, vol. 26, pp. 71-80, 1984.
22. F. Gerhart, "Methods of Associating Typewriter Ribbons and Correcting Tapes with a Questioned Text," *Journal of Forensic Sciences*, Vol. 34(5), pp. 1183-1195, 1989.
23. R. Hunton and J. Puckett, "Restoring Texts of Typewriter Ribbons: A Reliability Study of the RAW-1 Ribbon Analysis Workstation," *Journal of Forensic Sciences*, Vol. 39(1), pp. 21-27, 1994.
24. N. Sarah, "Typewriter Inks: An Annotated Bibliography," *Technology and Structure of Records Materials*, 2006.