CERTIFICATE COURSE IN QD & FINGERPRINT ANALYSIS **PAPER-I**

QUESTIONED DOCUMENTS EXAMINATION

Lesson Nos. :

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LESSON NO. 2.1 | **AUTHOR : DR. KOMAL SAINI**

TYPEWRITING AND PRINTED MATTER

TYPEWRITING IDENTIFICATION

2.1.1 INTRODUCTION

Handwriting comparison constitutes the bulk of the work of document examiner, but the typewritten documents also came for examination that involve pronotes, contracts, wills etc. Typewriters are used to produce fraudulent documents for the purpose of cheating, embezzlement etc. or anonymous letters and threatening letters.

This may be due to the idea that the typewriter has no individuality and hence typewriter frauds could not be detected. But this is just a misconception. The principles underlying the identification of typewritten documents are the same as those by which the identity of a person is determined. The identification in either case is based upon a definite combination of class and individual characteristics. Typewritten documents are questioned for ascertaining their date, source or to determine whether they contain fraudulent alterations or substituted pages.

All typewriting is not the same, but rather each specimen may in certain instances indicate the manufacturer and the period in which the machine was built. Identification of the particular machine on which the disputed matter was written can be done by comparing disputed specimen of typewriting with the specimens of specific typewriter. In fact, this identification is possible without ever seeing the machine itself or determining when and where it was made.

The basis of this identification is that every typewriter has individuality. It is often said that a typewriter prints with machinelike precision, but this precision differs under various conditions and the degree of variation depends on the particular mechanism i.e. the adjustments and tolerances of typewriter, use of a typewriter causes wear and damage to the working parts etc. All this leads to the appearance of individual defects or writing peculiarities in the work of every machine.

The identification of a particular typewriter from its work is established by combination of factors. The **first**, basic factor is the type size and type style or font. **Next factor** is the particular combination of the imperfections or defects shown in the typewriting together with the properly written characters. All these factors individualize a particular machine and establish its identification and a basic difference in any one of these factors can establish that a document was prepared on some other machine rather the one under consideration.

In addition to this, identification of a typewriter is also a function of its operating characteristics. That means that identification of a type bar machine involve a set of operating characteristics which are different from those of a single element, type ball machine, or an electronic single element, etc. however, the same type of peculiarities are required in all problems, although their frequency and importance differ with each class of machine.

Following are the different types of identifying defects which are used for an identification :

1. Printing defects
2. Machine defects
3. Variation
4. Transitory defects

2.1.2 PRINTING DEFECTS

The chief basis for identification is the defects or peculiarities found in the type impressions of work from a typewriter. They may be divided into two basic classes

a) Alignment defects and
b) Typeface defects

2.1.2.1 Alignment defects:

A typewriter is designed so that each character prints an even, uniform impression resting on or across an imaginary baseline and centered within allotted space along that line. But alignment is not always perfect in practice. They are:

2.1.2.1.1 Vertical alignment defect- Some characters print above or below the imaginary baseline of the script. The fault is most often found to be accompanied by inequalities of impression between the top and bottom of the letters.

2.1.2.1.2 Horizontal or Lateral alignment defect- Some characters print to the right or left of the space provided to them i.e. the letters are not equidistant from the letters preceding or succeeding it.

2.1.2.1.3 Oblique alignment defect or "off their feet"- Sometimes some of the letters are twisted on their axis so as to lean away from the proper slant i.e. right or left of the vertical. The typefaces strike the paper surface unevenly so that one edge or corner gives a heavier or darker impression than other parts of the letter, rather than the uniformly inked impression of a properly typewritten letter.

2.1.2.1.4 Double-impression or 'rebound'- At times a letter may consistently print appreciably too heavy or too light or may rebound, printing two impressions which do not superimposed over each other.

2.1.2.2 Typeface defects:

These anomalies consist of breaks in the impressions i.e. either the portion of the character is missing or there is a distortion in the outline of the character or serifs of the letters are missing or distorted. These irregularities results from the chips or bump in the type metal, and dented or irregular outlines of letters caused by damage to the typeface itself.

With a thorough and detailed study, each kind of defect can be discovered. In both classes, the defects may be slight, required careful examination under magnification. In case of misalignment, these defects were discovered by examining with alignment test plates.

2.1.3 MACHINE DEFECTS

Sometimes defects in the impressions due to other operational peculiarities of a typewriter may also assist in identification. Following are some of these defects:

- A consistently slight variation from the designed spacing between letters or lines;
- Slippage of the paper so that successive lines are not parallel;
- Skipping of a space after certain letters;
- Improper working of the ribbon that affects the printed impression;
- Irregular left margins or the stacking of letters on the right due to defective operation of the margin stops.

If any one of these defects repeat with regularity throughout a series of specimens, they can be considered as identifying feature of the machine.

2.1.4 VARIATION

Variation occurs in the work of a typewriter i.e. repeated impressions of the same character may not reflect the same evidence of defects in each impression. However, this variation occurs to a much lesser degree than in a person's handwriting. The kind and amount of variation present in the work of same typewriter are governed by several factors i.e.

- The condition of the machine in general, especially the play in moving parts of older machines
- The rough surface of a worn platen (roller) in particular
- The amount of ink on the ribbon
- The manner in which the keys are struck, i.e., uniformly or not particularly with a manual typewriter
- The weight of the impression, etc.

Variation is more apt to influence alignment defects, but it also affects certain typeface defects:

- Irregular typewriting rhythm, especially on a manual machine, may cause variation in the position of successive printings of the same letter.
- Letters 'off their feet' appear to print normally when struck heavily,
- Damaged and slightly battered typefaces may print without any apparent defect if the impression is well inked through a fabric ribbon.

In both instances, however, lighter impressions of these letters show their defective character clearly.

With some machines, successive impressions of certain letters show recurring variations. It may be explainable by such things as substantially different ribbon inking or it may, when repeated often enough, play a role in the ultimate identification. Under any circumstances it must be considered in any identification.

2.1.5 TRANSITORY DEFECTS

Transitory defects along with relatively permanent defects assist in the identification process. These defects are due to the factors such as **dirty typefaces and worn fabric ribbon**. Typefaces become filled in various ways and results in clogged

impressions of the letters. Standard specimens executed at approximately the same date as the questioned material may well contain these clogged impressions and thus makes valuable points of identification. Cleaning of the faces, however, immediately would eliminate these points of identification, and a new pattern is soon begun. Thus, if the standard and disputed matter were prepared at widely different dates, a different pattern of clogged typefaces cannot contradict a positive identification based upon a similar combination of alignment and typeface defects.

The condition of the fabric ribbon also play a part in identification, but its limitations nearly parallel those encountered with clogged typefaces. Principally because of the transitory nature of these factors, however, differences in them may indicate only different dates of execution, whereas to establish that a particular machine was not used means that the standard and questioned material must contain different patterns of permanent defects. Thus the test of consistency and permanence must always be applied in all such cases because it is only the permanent defects which permits and justify a positive conclusion.

PRINTED MATTER

2.1.6 INTRODUCTION

Printed document may be involved in crimes though the printed portions of a document but are generally not disputed. If whole document is suspected of being fraudulent/ counterfeit, the document examiner is expected to know about the production of the printed document. In addition to this, the printed portion of the genuine document that is under attack may contain significant evidence pointing towards its authenticity. If all factors of a document are to be analyzed, its printed portion must also be studied and interpreted correctly. So some knowledge of printing process is necessary to solve the problems related with printing processes.

2.1.7 LETTERPRESS PRINTING

Letterpress is the simplest method of transferring an image to paper and is also known as relief printing. Letterpress technique uses metal types which are raised above the background. Only these raised portions of typefaces are inked by the ink rollers. They are then pressed on to the paper to deposit the ink outlines. As only the raised area receives ink and touches the paper, the appropriate design is transferred to the paper. In letterpress printing, the metal type is set either by hand or machine and are arranged in units that make up the printed page. These pages are then transferred to the press for printing.

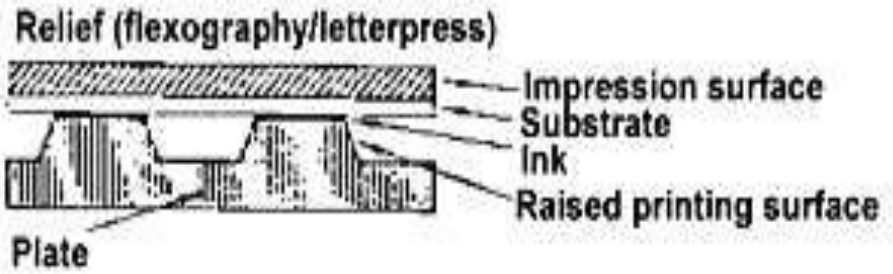


Fig-2.1.1 Diagrammatic representation of letterpress printing(*PNEAC, The Environmental Information Website for the Printing Industry.)*

Many forms of relief printing are in use. This technique is used to produce documents in relatively small numbers e.g. posters, letter headings etc. The same method can also be used to print counterfeit documents. More elementary forms of letterpress printing are by rubber stamps, post office cancellation stamps and toy printing sets.

2.1.8 LITHOGRAPHY OR OFFSET PTINTING

Lithography also known as offset printing, was invented at the end of the eighteenth century. Its name comes from the fact that it originally used a special absorbent stone as a printing plate. A water-repelling substance was painted on the stone that produced the image in reverse on the surface. Rest of the area on the stone was treated with water which moistened those areas that were not repelled by the coating. The greasy ink was then applied to the surface which adheres only to those areas where the water-repellent substance was coated. The inked stone was then pressed on to paper, the ink was transferred and the image printed.

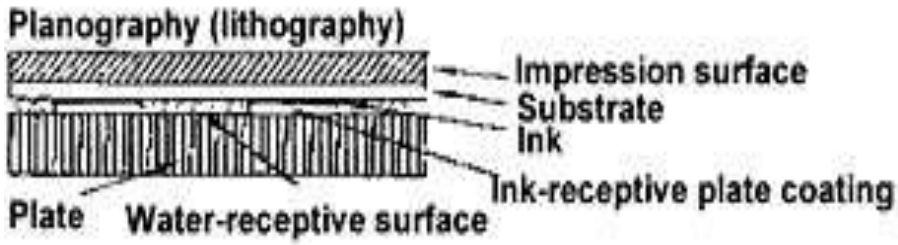


Fig-2.1.2 Diagrammatic representation of Lithography(*PNEAC, The Environmental Information Website for the Printing Industry.)*

Modern lithographic methods use smooth plates made by photographic processes and the image is off-set rather than produced by direct printing. The plates are prepared by projecting an image on to a sensitized plate which reacts to light. After development, the plates have been treated suitably so that the areas to be printed are made water-repellent, while the remainder of the plate becomes water-attractive. The plate is then moistened and the ink-roller is passed over it. The moist areas do not

accept the oil based ink while the other areas do. After the plate is inked, the image is transferred first to a blanket and from that to the paper.

Off-set lithography is widely used in commercial printing both in black and white and in color. Its usage ranges from inexpensive, quick service printing of poor quality to top quality-work including books, magazines and newspapers. As lithography/offset printing depends on photography to produce its plates, so it can be employed to copy other documents and is a commonly used method for making counterfeits.

2.1.9 GRAVURE OR INTAGLIO PRINTING

Gravure uses an image carrier or plate where the design to be printed is below the surrounding surface, whereas, letterpress printing is produced from a surface which is raised above its background and lithography uses a flat plate. The plate is then inked and the ink on the surface is scraped away with a doctor blade. Now the ink will remained in the depressions, and when the plate is pressed on to paper the ink is transferred in the shape of the image. Gravure, or intaglio, printing is commonly used for high quality products, especially for full color pictures.

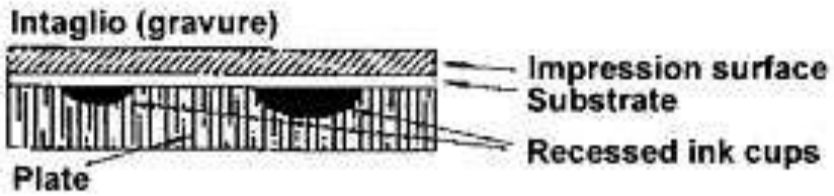


Fig-2.1.3 Diagrammatic representation of Intaglio printing (*PNEAC, The Environmental Information Website for the Printing Industry.)*

The plates are produced by two methods –

- Engraving and
- Photogravure

2.1.9.1 Engraving is used in bank note and other high grade security printing. The plates are made by mechanical means i.e. by hand or with the aid of machines. The method produces designs and lettering in solid lines but not the pictures.

2.1.9.2 A Photogravure is a photographic image produced from an engraving plate. The production of a photogravure consists of three steps:

1. Taking the picture;
2. Producing a printing plate of the image;
3. And printing the image on paper

After taking a picture, a glass transparency is made from the negative. Then a copper engraving plate is dusted with grains of bitumen and heated so that the bitumen becomes attached to the plate. A carbon print which has been exposed

beneath the transparency is then transferred to the plate. The plate is then bathed in warm water which causes the unexposed gelatin of the carbon print to be washed away, leaving the image in relief. Ferric chloride is then applied to the plate that eats into the copper in proportion to the highlights and shadows of the gelatin relief. The result is an etched copper plate of the original photographic image.

The final step, printing, involves spreading ink evenly across the plate and then pressing the plate onto the paper. The combination of the chemical and mechanical process produces an image both warm and precise. A photogravure looks like a photograph but is a series of connected lines, rather than unconnected dots as in a photograph.

Because the ink which is to be transferred to the paper has to be held for a short time in the depressions in the plate, large areas cannot be printed without a further operation. A grid is placed between the pictures to be printed and the light sensitive plate so that instead of solid areas a series of small cells is etched on the surface. When the design is printed the ink from the cells overlaps so that a continuous tone is produced. By varying the depth or width of the cells, different densities of color can be obtained. Full color printing is achieved by the methods as in lithography using three or more colors each on a different plate.

2.1.10 RAISED PRINTING

Embossed printing is raised from the surface of the paper. It is produced by two plates, one with the image to be printed in relief and the other with the image depressed into the surface. The depressions are inked and the paper is forced into them by the relief image. The result is the transfer of a much larger quantity of ink than is normal in other methods of printing.

Thermography is a technique which produces similar effects but by a different process. In this, the image is printed with a slow-drying ink which is then dusted with resinous powder. The paper is then pressed through a heater. As a result, the powder fuses to the paper and swells, giving a raised effect.

2.1.11 SCREEN PRINTING

Screen printing depends on squeezing ink through a mesh made of nylon, silk, or other materials. The non-printing areas are covered with a stencil so that only the uncovered parts of the screen allow ink to pass through. The method is used for short runs. Its main advantages are that thick coatings of ink can be transferred.

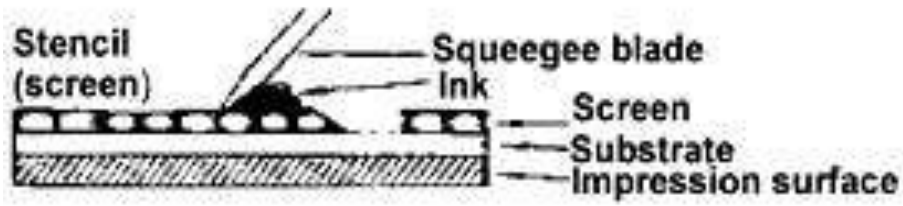


Fig-2.1.4 Diagrammatic representation of screen printing (*PNEAC, The Environmental Information Website for the Printing Industry.)*

2.1.12 NON-IMPACT PRINTING METHODS

An entirely new field has been developed with non-impact printers. These methods are:

- Xerography, where the image is transferred from a drum to paper by a change in a static electric charge,
- laser printing – which is almost a similar method;
- Ink jet printing that forces the ink at the right places on the paper, guided by electrostatic forces.

2.1.13 IDENTIFICATION OF PRINTING METHODS

Observation of printed material with the aid of a microscope can give an identification of the printed method used to produce it because the type of plate, relief, lithographic, or gravure, will produce characteristic effects on the surface of the paper. In addition to this, the type of ink used can also give an indication of the printing process.

The printing methods represent clearly different techniques. Letterpress utilizes raises type, while offset printing is produced a smooth plate that has been treated so that the ink only adhere to the portion to be printed. Offset and letterpress printing can be distinguished through very careful examination.

The slight embossing of letterpress work or the quality of letter in imprint are elements to be considered. If the press work is not of the highest quality, the differences may be recognized more readily. Likewise, poor-shop work in preparing assembled master copies for offset reproduction may reveal slight flaws in the finished printing. With both methods there is great number of possible types of designs, and some are very similar for the two processes.

Typeset material can be a additionally used for technical examination. Many different fonts are in use today, but not all shops can supply each. Determination of a font used to print a suspected document may greatly assist in locating the plant at which the printing was done. The information of the way the type was set i.e. by typesetting machine or by hand, and the quality of type setting or the press work, can be derived from a study of the document itself which may have some value in the investigation of the problem. Many standard forms prepared by letterpress or offset have printing codes that identify their source.

Thus certain questions can be answered from the printed document alone, but far more can be told by comparison of it with known material.

LETTERPRESS

Letterpress or relief printing depends on raised type transferring ink to the paper. Considerable pressure is required to accomplish this. The inked type faces are

pressed on to the paper. The pressure may force the ink outwards towards the edges of the letter where it escapes and settles. The effect is known in the printing industry as 'squash'.

The pressure exerted by the typeface may cause indentations on the surface. Examination with oblique light or by touch will reveal that the paper surface is not smooth but indented by the printing. A combination of uneven inking or squash with the indentation of the printed lettering is indicative of letter press or relief printing.

LITHOGRAPHY

A lithographic method depends on the deposition of the ink from a flat surface. As there is no difference in pressure between image and the non image areas no indentations are formed. The ink will be evenly distributed through the printed matter with normally no concentration at the edges.

As this technique depend on the photography for the preparation of the plates. The processes used cause the image to lose some of the details of the original i.e. sharp corners and edges become rounded and tend to lose their definition, sometimes to the extent that small lettering will become indistinct. These features are typical of lithography but in well printed material the lack of sharpness is apparent only under microscopical examination.

GRAVURE

A variation in the thickness of the ink on the paper is an indicative of this method of printing.

2.1.14 PROPOSED QUESTIONS

1. Discuss the importance of alignment defects in typewriting identification?
2. How will you distinguish and identify printed matter produced by letter-press printing, photographic printing and Intaglio printing.
3. Can you fix the probable date of typewritten document? Explain
4. Explain why carbon copy made in the same process of typing does not coincide exactly on superimposition with original copy?
5. Write short note on:
    a. Proportionate spacing.
    b. Clogged typeface.
    c. Pitch of typewriting.
    d. Printing defects

2.1.15 SUGGESTED/REFFERED BOOKS

1. Hilton, O (1982): Scientific Examination of Questioned Documents. Revised Ed. Elsevier Science Publishing Company, NY.
2. Harrison, W.R. (192.16): Suspected documents: their Scientific Examination. Sweet and Maxwell Ltd., UK.

3. Saxena B.L. (1994): Law and Techniques Relating To Identification of Handwriting, Disputed Documents, Finger Prints, Foot Prints and Detection of Forgeries,(Revised by Singla A.K.) Central law Agency, Allahabad.
4. Ellen, D. (1989): The Scientific Examination of Documents: methods and Techniques. Ellis Horwood Limited, Chichester.
5. National Environmental Assistance Center PNEAC, The Environmental Information Website for the Printing Industry.

AUTHOR : Ms. Deepika Bhandari

TYPEWRITERS AND PRINTERS

INTRODUCTION TO TYPEWRITERS

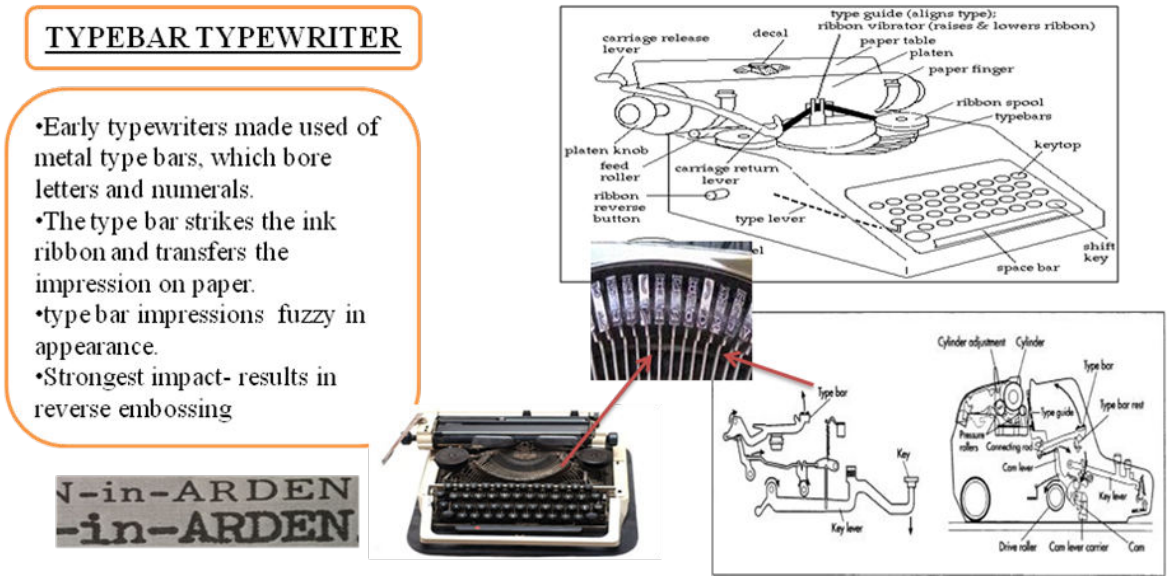
Type writer is a mechanical device to produce printed characters on a piece of paper by typing individual keys. Typically, a typewriter has an array of keys, each of which causes a different single character to be produced on the paper by causing an inked ribbon to be struck against the paper by a type element similar to the sorts used in movable type letterpress printing.

At the end of the nineteenth century, the term typewriter was also applied to a person who used a typing machine. **In 1829, American William Austin Burt patented a machine called the "Typographer" which, in common with many other early machines, is listed as the "first typewriter"**. The Science Museum (London) describes it as "the first writing mechanism whose invention was documented". In 1865, Reverend Rasmus Malling-Hansen of Denmark invented the Hansen Writing Ball, which went into commercial production in 1870 and was the first commercially sold typewriter. It was a success in Europe and was reported as being used in offices in London till 1909. Malling-Hansen placed the letters on short pistons that went directly through the ball and down to the paper. This, together with the placement of the letters so that the fastest writing fingers struck the most frequently used letters, made the Hansen Writing Ball the first typewriter to produce text substantially faster than a person could write by hand.

The first typewriter to be commercially successful in America The Sholes and Glidden type writer by Christopher Sholes and Carlos Glidden was invented in 1868. It looked something like a cross between a piano and a kitchen table. In the early 1880s Index Type writer which uses pointer to choose letters from an index came in market.

TYPES OF TYPE WRITERS:

1. **TYPEBAR TYPE WRITER:** Early typewriters made use of metal type bars, which bore letters and numerals. Each key is connected to a typebar that lifted a typeface to strike the paper. Each typeface has upper and lower case forms of a letter or numbers and symbols. The assemblage of typebars and typefaces is called the typebasket. The keyboard is at the front. The paper moves from right to left on the carriage at the back. In between, is a complex arrangement of levers and springs. A typewriter like this is completely mechanical: powered entirely by fingertips, it has no electrical or electronic parts.



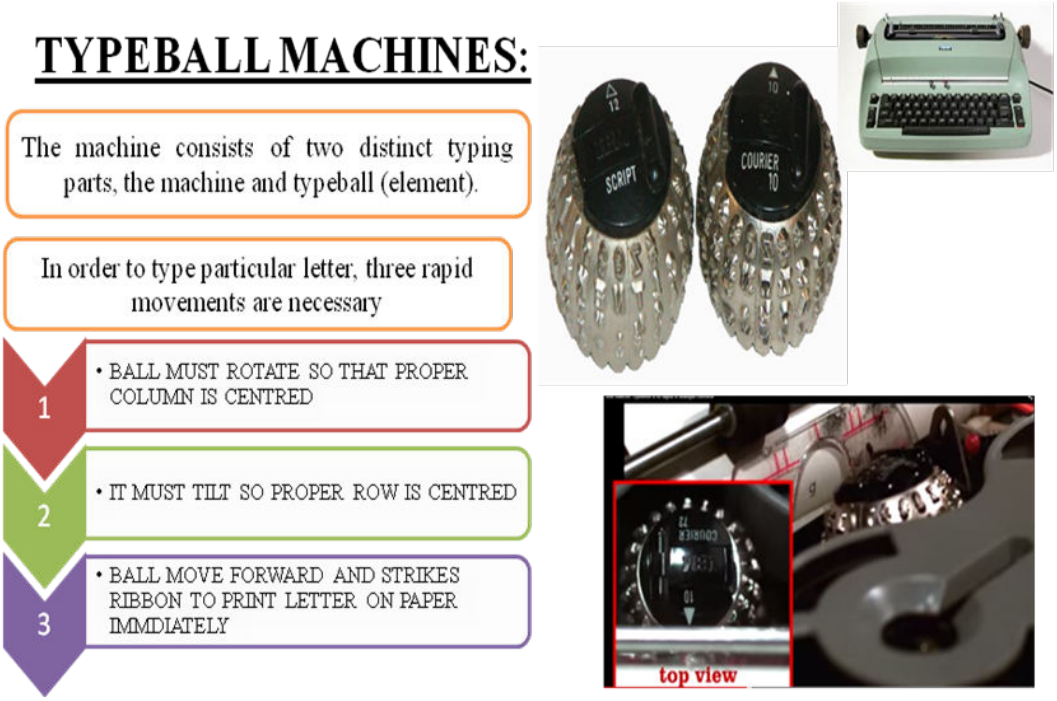
Working of Typebar Typewriter: When one presses a key, lever attached to it swings another lever called a type hammer up towards the paper. The type hammer has the

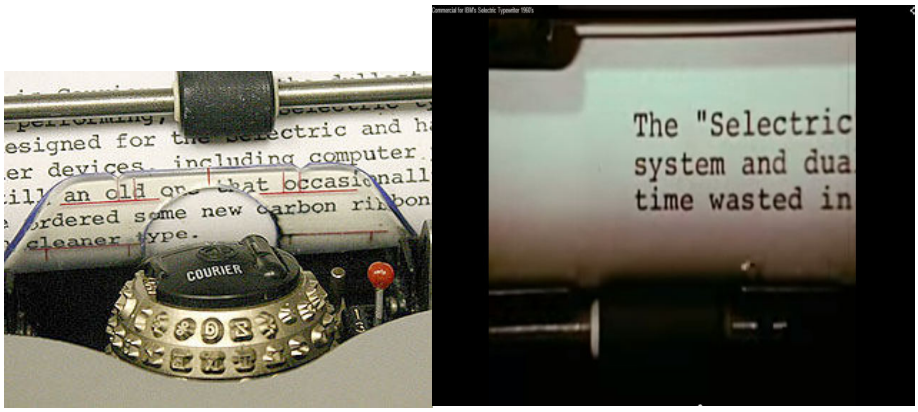
slug of metal type on the end of it. Just as the type is about to hit the page, a spool of inked cloth called a ribbon lifts up and sandwiches itself between the type and the paper, so the type makes a printed impression as it hits the page. When you release the key, a spring makes the type hammer fall back down to its original position. At the same time, the carriage (the roller mechanism holding the paper) moves one space to the left, when you hit the next key it doesn't obliterate the mark you've just made. The carriage continues to advance as you type, until you get to the right edge of the paper. Then a bell sounds and you have to press the carriage return lever. This turns the paper up and moves the carriage back to the start of the next line.

Type of type-bar strikings:

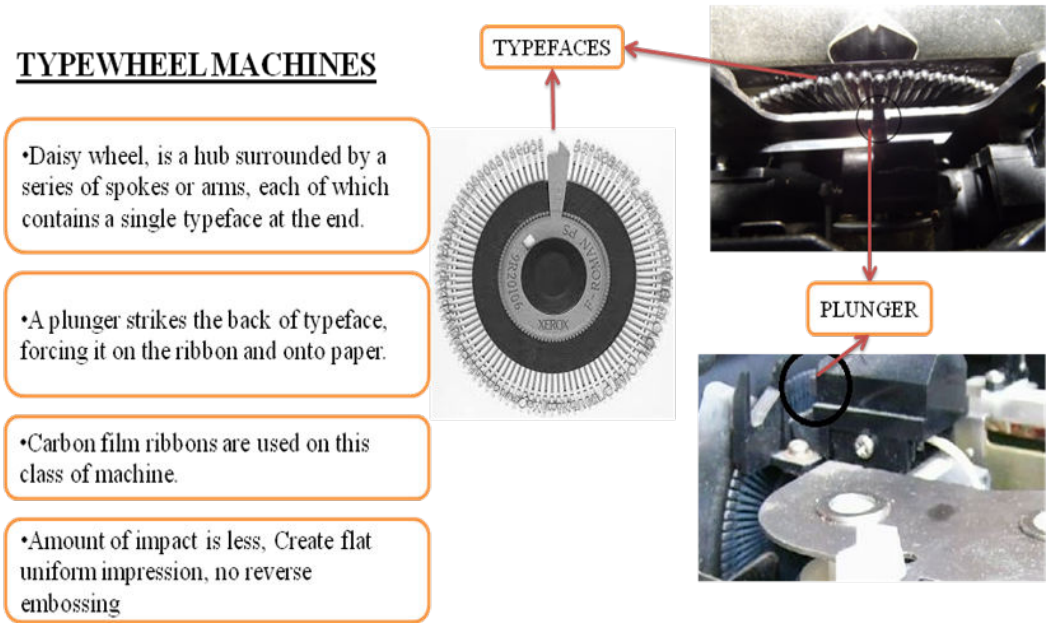
- **Back-stroke**: Type-bars positioned at the rear, behind the platen, and striking downward towards the paper. This arrangement is commonly known as the backstroke method. The type-bars on down-strike typewriters are arranged in a nearly vertical semi-circle between the keyboard and carriage, and they strike downward. Paper handling was inconvenient; a sheet of paper was rolled into a holder behind the keyboard where it fed into the platen. Visibility was limited to only a few lines of type before the paper returned into the paper holder. Example: Brooks Type writer.
- **Front striking**: In most of the early typewriters, the type-bars struck upward against the paper, pressed against the bottom of the platen, so the typist could not see the text as it was typed. What was typed was not visible until a carriage return caused it to scroll into view. The difficulty with any other arrangement was ensuring the type-bars fell back into place reliably when the key was released. This was eventually achieved with various ingenious mechanical designs and so-called "visible typewriters" which used front-striking, in which the type-bars struck forward against the front side of the platen, became standard.

2. **TYPE-BALL TYPE WRITER:** Instead of the "basket" of individual type-bars that swung up to strike the ribbon and page in a typical typewriter of the period, the type-ball typewriters had a "typing element" (frequently called a "type-ball", or more informally, a "golf ball") that rotated and pivoted to the correct position before striking. Ball must rotate so that proper column is centered and it must tilt so proper row is centered. Ball moves forward and strikes ribbon to print letter on paper immediately. These are the **3 rapid movements** which are necessary to type a particular letter. The ribbon is a carbon film consisting wax coating of polyethylene base. The impressions created are crisper than the fabric ribbons. The impressions are somewhat uneven in depth and deeper towards the edges because of the continuous movement of the ball striking the paper. The tilt and rotation are activated by low-power mechanical actions. Example: IBMs electric Type writer.





3. **TYPE-WHEEL TYPE WRITERS:** The main part of this type writer is a Daisy Wheel. Daisy wheel is a hub surrounded by a series of spokes or arms. Each arm contains a single typeface at the end. A plunger strikes the back of typeface, forcing it on the ribbon and onto paper. Carbon film ribbons are used on this class of machine. Amount of impact is less, creates flat uniform impression and no reverse embossing.



INTRODUCTION TO PRINTERS

In computers, a printer is a device that accepts text and graphic output from a computer and transfers the information to paper, usually to standard size sheets of paper. Printers are sometimes sold with computers, but more frequently are purchased separately. Printers vary in size, speed, sophistication, and cost. In general, more expensive printers are used for higher-resolution color printing.

The four printer qualities of most interest to most users are:

Color: Color is important for users to print pages for presentations or maps and other pages where color is part of the information. Color printers can also be set to print only in black-and-white. Color printers are more expensive to operate since they use two ink cartridges (one color and one black ink) that need to be replaced after a certain number of pages.

Resolution: Printer resolution (the sharpness of text and images on paper) is usually measured in dots per inch (dpi). Most inexpensive printers provide sufficient resolution for most purposes at 600 dpi.

Speed: If you do much printing, the speed of the printer becomes important. Inexpensive printers print only about 3 to 6 sheets per minute. Color printing is slower. More expensive printers are much faster.

Memory: Most printers come with a small amount of memory (for example, one megabyte)

A **printer** is an electromechanical device which converts the text and graphical documents from electronic form to the physical form. Generally they are the external peripheral devices which are connected with the computers or laptops through a cable or wirelessly to receive input data and print them on the papers. A wide range of printers are available with a variety of features ranging from printing black and white text documents to high quality colored graphic images.

TYPES OF PRINTERS

Since the invention of the printing technology, a variety of technologies have been employed in computer printers. Broadly printers are categorized as impact and non impact printers. Impact printers are the type of printers in which a key strikes the paper to make a letter. The examples of Impact printers are Daisy wheel and Dot matrix printers. While non-impact printers do not operate by striking a head against a ribbon. Inkjet printers and laser printers are the non-impact printers.

1. IMPACT PRINTERS

Impact printers include all printers that print by striking an ink ribbon. Impact printers use a print head containing a number of metal pins which strike an inked ribbon placed between the print head and the paper.

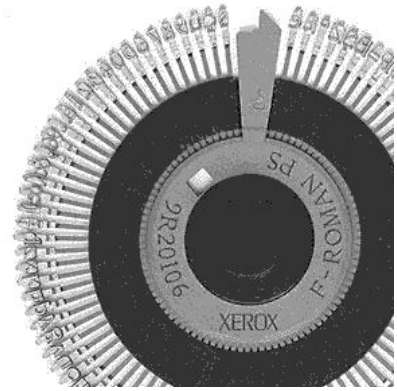
- In impact printers, there is physical contact with the paper to produce an image.
- Impact printers are ideal for printing multiple copies
- Due to its striking activity, impact printers are very noisy.
- Since they are mechanical in nature, they tend to be slow.

Few of the Impact printers are mentioned below:

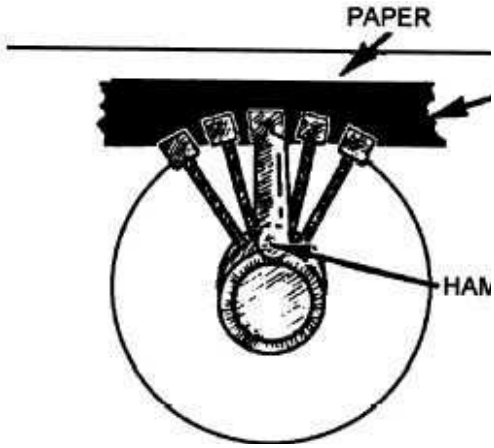
A. Daisy wheel
B. Dot matrix
C. Pen based plotter

D. Line printer
E. Typewriter-derived

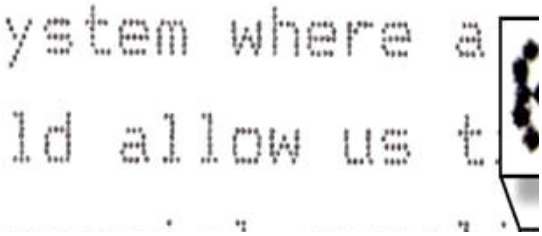
A. **DAISY WHEEL PRINTERS:** A Daisy wheel printer usually prints only characters, symbols and not graphics. By 1980 these printers attained their demand due to the printing quality. But as Laser and Inkjet Printers prices were affordable and Dot Matrix Printers had improved to an extent, these printers were not in picture.



Working of daisy wheel printers: These printers are similar to the typewriter. Daisy wheel is a circular part which is shown in the above images; it is called as heart of these printers. Circular element contains all text, symbols and numeric which is been molded on the circumference of the circle's each petal. The printing part rotates rapidly and stops to allow the printing hammer to strike commanded character against paper.



B. **DOT MATRIX PRINTERS:** Dot matrix printers and Inkjet printers' uses same key characteristics; they both create output with small dots. In Dot matrix printers, a pin presses through a ribbon to make an impact on the page. These printers have obtained benefits even though their technology is old.



C. PEN BASED PRINTERS: These are the types of devices commonly used for computer applications, especially for designs in the field of architecture. By moving pen onto the paper, plotter draws lines onto the surface. It draws just like paint application in the computer. They cannot produce raster graphics.

Working : Two main types of plotters are FLATBED plotters and DRUM plotters. FLATBED plotter uses system where paper is fixed at once and pen is been moved onto the paper up and down, right and left. Whereas DRUM plotter moves the pen up and down and paper right and left. Plotters can use more than one pen and draws different colors.

D. LINE PRINTERS: These printers print one line at a time. Usually fed with tractor feed printer paper, line printers were the first high-speed printers used in data processing. Nowadays, the classical, mechanical line printer has mostly been replaced by laser printers or line matrix/shuttle matrix printers.

Principle of operation: Data is sent from the host to the device. It buffers a line at a time. A print chain (imagine a cross between a bicycle chain and the types of a typewriter) moves in front of a hammer bank with one hammer per print position. Whenever the correct letter on the chain is in front of one of the hammers, the hammer hits the character on the chain, which in turn will hit the ribbon, creating an imprint on the paper. As soon as the line is completed, paper is advanced by one line. The whole process is rather noisy, print quality is

limited and except for bolding, and underscoring there is no real variation in the (fixed-width) fonts.

Working: Line printers as well as serial dot matrix printers use pins to strike against the inked ribbon, making dots on the paper and forming the desired characters. The differences are that line printers use hammer bank (or print-shuttle) instead of print head, this print-shuttle has hammers , and these hammers are arranged in a horizontal row .The hammer bank uses the same technology as the permanent magnet print head with the small difference that instead of print wires the print-shuttle has hammers. The printing mechanism works as follow. The permanent magnetic field holds the hammer spring in stressed, ready to strike position. The driver sends electrical current to hammer coil, which then creates electromagnetic field opposite to the permanent magnetic field. When both fields equalize, the energy stored in the spring is released to strike the hammer against the ribbon and prints a dot on the paper.

E. **TYPE WRITER :** Typewriter is a mechanical letter writing machine. Before personal computer became popular all over the world in 1980s, It was likely that everybody had typewriter. It is completely manual, no electricity used. It is called typewriter because it allows us to write on the page. Writing was carried out with the piece.

Type: Slugs of metal, with the raised letter on them and these letter are molded on them in reverse so that they correctly on the page.

The paper moves from right to left on the carriage at the back. In between, is a complex arrangement of levers and springs.

Working: The basic idea is simple: you press a **key**,

(1) **LEVER** (alphabet keys) attached to it

(2) Swings another lever called a **type hammer**

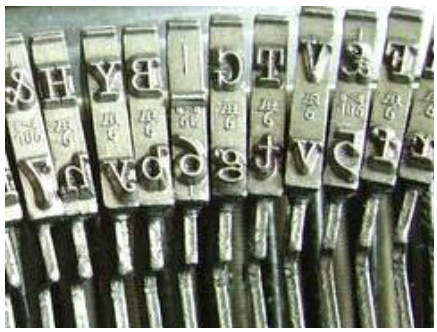
(3) Up toward the paper. The type hammer has the slug of metal type on the end of it. Just as the type is about to hit the page, a spool of inked cloth called a **ribbon**

(4) Lifts up and sandwiches itself between the type and the **paper**

(5) So the type makes a printed impression as it hits the page. When you release the key, a spring makes the type hammer fall back down to its original position. At the same time, the **carriage**

(6) (The roller mechanism holding the paper) moves one space to the left, so when you hit the next key it doesn't obliterate the mark you've just made. The carriage continues to advance as you type, until you get to the right edge of the paper. Then a bell sounds and you have to press the **carriage return lever**

(7) This turns the paper up and moves the carriage back to the start of the next line.



2. NON IMPACT PRINTERS

Non-impact printers are much quieter than impact printers as their printing heads do not strike the paper. Non-impact printers include laser printers, inkjet printers and thermal printers.

- Non-impact printers are faster than impact printers.

- They are quiet than impact printers because there is no striking mechanism involved.
- These printers produce high-quality graphics

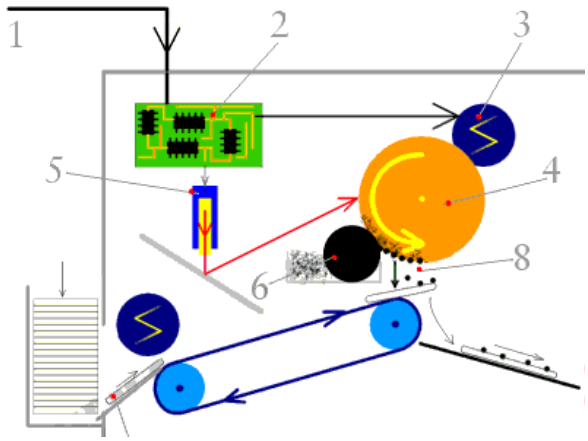
Few of the Non Impact printers are mentioned below:

A. Laser Printers
B. Inkjet Printers
C. Solid ink
D. Dye-sublimation
E. Thermal wax
F. Thermal paper
G. Inkless
H. Monochrome vs Color
I. Digital offset printers

A. LASER PRINTERS: When we print something our computer sends vast stream of electronic data to our laser printer. An electronic circuit present in the printer it detects what all data it needs and what it need to look like. It makes a laser beam scan across the page on both the sides of it, building up a pattern of static electricity. And this attracts onto the page a kind of powdered ink called toner. Finally, as in a photocopier, a fuser unit binds the toner to the paper.

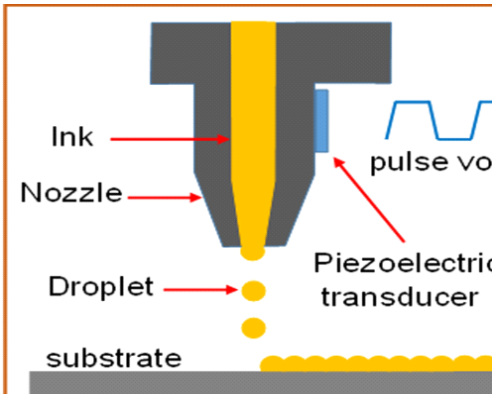
- Millions of bytes (characters) of **data** stream into the printer from your computer.
- An **electronic circuit** in the printer (effectively, a small computer in its own right) figures out how to print this data so it looks correct on the page.
- The electronic circuit activates the **corona wire**. This is a high-voltage wire that gives a static electric charge to anything nearby.
- The corona wire charges up the **photoreceptor drum** so the drum gains a positive charge spread uniformly across its surface.
- At the same time, the circuit activates the **laser** to make it draw the image of the page onto the drum. The laser beam doesn't actually move: it bounces off a moving mirror that scans it over the drum. Where the laser beam hits

the drum, it erases the positive charge that was there and creates an area of negative charge instead. Gradually, an image of the entire page builds up on the drum: where the page should be white, there are areas with a positive charge; where the page should be black, there are areas of negative charge.



- An **ink roller** touching the photoreceptor drum coats it with tiny particles of powdered ink (toner). The toner has been given a positive electrical charge, so it sticks to the parts of the photoreceptor drum that have a negative charge (remember that opposite electrical charges attract in the same way that opposite poles of a magnet attract). No ink is attracted to the parts of the drum that have a positive charge. An inked image of the page builds up on the drum.
- A sheet of **paper** from a hopper on the other side of the printer feeds up toward the drum. As it moves along, the paper is given a strong positive electrical charge by another corona wire.
- When the paper moves near the drum, its positive charge attracts the negatively charged toner particles away from the drum. The image is transferred from the drum onto the paper but, for the moment, the toner particles are just resting lightly on the paper's surface.
- The inked paper passes through two hot rollers (the **fuser unit**). The heat and pressure from the rollers fuse the toner particles permanently into the fibers of the paper.
- The **printout** emerges from the side of the copier.

B. **Ink-Jet Printer** : Ink jet printers prints character by spraying ink on paper from a nozzle which is having a very fine hole. Specially made ink is been pumped out from nozzle in the form of vapors which creates letters and shapes. These printers produces higher quality printouts. They have an electrical signal which a very little amount of ink to squirt onto the paper.



C. **SOLID INK PRINTERS:** Solid ink technology was first developed by a company called Tektronix which was later bought up by Xerox in the year 2000. This is a simple technique and based on simple technical design, consists of three major components:

- A maintenance roller applying oil to the print drum
- A **printhead** transferring ink to the print drum via 1,236 **nozzles** jetting more than 30 million ink drops per second.
- A print drum transferring the image to the paper

The printing process looks as follows:

- For the sake of releasing reliable ink, roller applies a layer of silicon oil to the heated drum.
- The print head applies all colors at the same time on the rotating drum.
- A sheet of paper is rapidly kept between the rotating drum and a transfix roller.
- Transferred ink to the paper.
- The ink dries, penetrates and solidifies faster.
- The ink fuses with the paper by heat and pressure.
- If the printer is set to print on both the sides, the paper is feed back into the duplex paper path. The paper takes one more turn in the printer and gets printed on the other side.

D. **DYE SUBLIMATION PRINTERS:** Dye sublimation Printers produces high quality output.

Working: Dye sublimation printing starts with films containing dyes. Either there will be single four layered films (cyan, magenta, yellow and gray) or separate films for each color from these four colors mentioned. Because these films contain the pigments and they will appear as red, blue, green, and gray.

During the printing process, the films are placed on the paper and heated up by the print head.This will cause the pigments to leave the film and enter into the paper where it cools re-solidifies. This is the "sublimation" part. Sublimation means to heat something and turn it into a vapor, then to form it back into a solid. Because the pigments go from solid, to gas, and back to solid, there is little mess compared to ink.

E. **THERMAL WAX PRINTERS:** There are various types of printers. And printer with one variation is Thermal Wax Printers. It is functionally designed like Dye Sublimation Printers. These printers work by melting colored wax onto paper in small droplets, as opposed to saturating paper with dye or pigment based inks.

   Working: The difference between thermal based printers and dye sublimation printers is only the manner in which ink is been transferred onto the paper. While dye sublimation printers saturate paper with ink that must dry first and thermal printers uses an ink ribbon made up of wax which is heated and transfers print data onto the paper. Thermal wax printers are used to print bar codes and shipping labels

F. **THERMAL PAPER PRINTERS :** The paper which we get after implementing it to these printers is different and unique, because the chemicals are coated on it. Sometimes it even have odd smell, the paper is slippery and possess unique structure too which doesn't allow us to write anything on it.

G. **INK LESS**: Xerox is developing inkless printing method. But the working is radically different. They are not long lasting in terms of durability, but Xerox is turning this drawback into an asset. In fact they are working to make inkless prints easily erasable.In offices employees prints these papers to use it just for a day or even lesser than that. As this economically and environmentally useful, Xerox is developing paper that doesn't require ink and is completely reusable.

Working: Xerox first coats paper in Heliochromic chemicals. These chemicals result paper to darken when it is exposed to UV light. These are similar to chemicals which causes sunglasses to darken to black when it get exposed to sunlight and slowly lighten in dim light. The printer prints by zapping paper with right wavelength of UV light and in the right places. And then print can be erased immediately with other right wavelength of light. In this technology, prints automatically fade off within 16-24 hours after printing.

I. **MONOCHROME VS COLOUR PRINTERS:** Color printers work on the same concept of monochrome printers. They use four color toners (ink cartridges in case of inkjet printers) instead of one black colored toner in the black and

white printers. The colors which are used for print are Cyan, magenta, Yellow and Black. All these fours colors are associated with four different drums. When printer receives the printing data, the paper is charged corresponding to the different color drums. The paper passes through each drum and the corresponding color toner particles gets stuck on the paper. As the paper passes through all four drums, the desired colored shape gets printed on the paper. Since the paper passes through four drums, color printers are four times slower than the monochrome printers and several times expensive.

J. DIGITAL OFFSET PRINTERS: The term digital printing can be broadly defined to include any reproduction method that uses electronic files and dots to produce an image using ink, toner, inkjet, or other dye- or pigment based imaging system. Because a digital printer redraws the page image for each print rather than relying on a press plate to carry the image, a digital print requires no setup sheets and each sheet can contain a different image.

Working: Digital printing begins with creation of the document file – the words and images that will print on the page. Regardless of what program is used to create the file or any of its components, the file is converted into a raster graphics image. A raster is a grid of x and y coordinates on a display space; a raster image file identifies which of those coordinates to illuminate. A raster image file is sometimes referred to

as a bit map because it contains information that is directly mapped to the display grid. BMP, TIFF, GIF and JPEG are all examples of raster image file types. The action of converting a file to a raster image file is known as raster image processing or RIPping. To prepare for digital printing, all files must be RIPped to create the bit map that will guide the imaging device (usually laser or inkjet) to print the dots in the right place. As we mentioned before, digital printing devices use a variety of technologies to create the image: wet or dry toner, inkjet, and dye- or pigment-based systems. The most frequently used are dry toner based printers and inkjet printers. Laser printers use the pulses of light from a laser beam to create images on a light-sensitive surface. The images are formed from dot matrix patterns, typically 240 x 240 dots per inch, 300 x 300 dots per inch or 600 x 600 dots per inch. The laser printer uses technology similar to a copier, based on the principle of the attraction of opposite electrical charges. Using the bit map information from the RIPped file, the laser beam exposes an electrically charged photoreceptor, changing the charge to the opposite of the rest of the photoreceptor. Toner particles are attracted to the photoreceptor, and then transferred to paper. The toner is fused to the paper by passing the paper through hot rollers (approximately 400 degrees). The heat required to fuse the toner to the paper introduces some limitations to the type of stock that can be used in a laser printer.

Toner is a fine, negatively charged, plastic-based powder. The plastic particles ensure that the toner will “melt” when heated by the fuser. Toner is manufactured by mixing pigment (either black or colored) with molten polymer, then cooling the mixture and crushing it in a milling process. This creates toner particles of between 7 and 10 microns. The size of a toner particle is relevant to the resolution of a printed image. Because the toner must adhere to the dots of a bit map, it is important to maintaining the resolution of the image that the toner particles be no bigger than the dots. High speed digital production printers use microfine toner; this is why we can hold a finer resolution than is possible with a desktop laser printer.

LESSON NO.2.3

AUTHOR : Ms. Deepika Bhandari

ANALYSIS OF TYPESCRIPT

Introduction

An abundance of crucial information can be gleaned from documents related to a criminal or civil case. The suicide note found next to the deceased—was it actually written by a killer trying to cover up his crime? The bank robber's hold-up note—does it contain invisible impressions that indicate the address of the hideout? The will of a wealthy person—was it altered so a relative could receive a windfall? The discipline of forensic document examination, often referred to as "questioned documents," is frequently associated with white-collar crimes such as check fraud; however, in practice, this area of forensic science can be used in a wide array of cases from medical malpractice to art forgeries to homicides. Armed with sophisticated technology, forensic document examiners can peer into the visible and invisible marks on a document to extract an abundance of details that may verify authenticity or provide additional information crucial to the investigation. The digital age has made the work of forensic document examiners even more important. With the availability of powerful software programs such as Adobe Photoshop, Acrobat and others, it has become significantly easier for criminals to create and manipulate all manner of fraudulent documents from contracts to currency.

Principles of Forensic Document Examination

Forensic document examiners often deal with questions of document authenticity. To determine whether a document is genuine, an examiner may attempt to confirm who created the document, determine the timeframe in which it was created, identify the materials used in its preparation or uncover modifications to the original text. Documents can be examined for evidence of alterations, obliterations, erasures and page substitutions. Or the examiner can study the methods, materials or machines that created the document, providing key information that can identify or narrow the possible sources of the document. The ink, paper, writing tools, ribbons, stamps and seals used in production of the document may all reveal important clues. The examiner may even discover valuable evidence in a document's invisible impressions. A key element of document examination focuses on handwriting. Forensic examination and comparison of handwriting, which includes hand printing and signatures, is based on three main principles: (1) Given a sufficient amount of handwriting, no two skilled writers exhibit identical handwriting features; (2) every person has a range of natural variation to his or her writing; (3) no writer can exceed

his or her skill level (i.e., it would not be possible for a marginally literate person who has only learned to produce very basic hand-printed letters to execute perfectly formed, highly skilled cursive writing).

Why and when is forensic document examination used?

Since documents are part of daily life, forensic document examiners work a wide variety of cases. Forensic document examiners are called to investigate the authenticity of documents in situations such as:

- forgeries
- counterfeiting
- identity theft
- fraud
- suicides
- homicides
- bank robberies
- kidnappings
- extortion
- stalking
- contested wills
- contested contracts
- medical malpractice
- title / deed lawsuits.

Forensic document examiners are most frequently asked to resolve questions of authorship. Is the signature on the mortgage loan genuine? Who wrote the anonymous note? Did the deceased sign the will? By comparing documents found at a crime scene to a suspect's known writing samples, the forensic document examiner can help confirm who wrote the note and include or exclude suspects from the investigation.

OFFICE MACHINES

1. **Copiers:** Photocopy machines can be identified by "trash marks." Trash marks are small marks on the copy from marks that were on the document being copied or from extraneous toner fused onto the copy. Any copies made from that document thereafter will bear those trash marks. Trash marks can also be made by flaws or damage on the drum, scratches on the glass platen, or marks from the lid if the paper does not cover the entire imaging area. These marks from defects can be traced back to the machine producing the defective marks. Owing to maintenance and repair and even cleaning the glass platen, these marks can be transitory. Using the time frame when the marks were present on other copies made by the machine, suspect documents can be dated relative to the time that the marks first appeared and the repair or cleaning was performed. Repeated

patterns of photocopier trash marks transferred to subsequent copies. Manipulation of documents by photocopier began and still may be done by the cut-and-paste method. On older machines, the outlining of the cut-outs were frequently obvious. Darkness and lightness adjustments can be made to minimize the cut-out marks. Newer machines can use the central processing unit to eliminate areas on the intended copy. As early as 1985, photocopiers were introduced where two documents could be placed in juxtaposition on the platen and the signature on one document transferred to the other without a trace of alteration. Defects in the transport system, rollers, fusers, and drum that impart individual markings to the document can be of identifying value. Gas chromatograph/mass spectrometer analysis of the toner may serve to identify a class characteristic feature such as the manufacturer. Colour copy machines produce a pattern that can be examined microscopically. This pattern is a set algorithmic pattern that can be traced back to a specific machine. So all colour copies made on a machine have this pattern imprinted on each copy identifying the source. Analysis of the toners may be a significant factor in identifying machines. There is also evidence that some aging determination can be made on photocopy toners.

2. **Fax Machines**: Fax machines produce a transmitting terminal identifier (TTI) that is a line of data (sending number, date, and time) across the top or the bottom of the facsimile copy, if the information is properly programmed into the machine. This is generated by the sending machine in the transmitting terminal and thus will have a different font than the text of the fax document. This may become significant if the fax copy is manipulated to appear as if it were sent from another machine, such as a "cut-and-paste" method. Some receiving machines will override the sending machine's font style for the TTI and use their own font. The American Society of Questioned Document Examiners has produced a collection of fax machine fonts to identify font styles with models and machines. Analysis of toners may be a significant factor for tracing the source of a fax.
3. **Typewriters**: Typewriters can be traced to manufacturer and model by examining the font. There are search systems and computer programs that assist in tracing type fonts to classes of machines. The degree of certainty of this type of search results in grouping the typing into a general category. Depending on the extent/volume of the typing, a determination of the manufacturer can be made and sometimes Forensic Document Examination can also identify the model of typewriter. However, there is more than one company that manufactured daisy wheels for other companies' machines. This type of determination is completely different than identifying the actual machine that did the typing. The narrowed down category could be a large group of machines that fit into the same classification. If there is a limited amount of typing, less than a full strike up,

then the determination may not be narrowed down very far unless there is some very unique character in the questioned typing. Single element typewriter identification is a more unique identification problem than the type-bar machine. The ball fonts and daisy wheels are interchangeable from machine to machine of the same manufacturer. The identification is dependent on both the typing element defects and defects in the function of the machine unit on which the element is mounted. Thus, a change in either the single element or the typing unit can affect the identification. Specific damage/defects to the typeface of the element can be used to identify the specific element. Defects caused by wear and malfunction of the typing unit remain consistent within the machine and can be used to identify the actual machine. These defects do not change when a different element is interchanged. This is true with ball element typewriters and daisy wheel machines. Character alignment, spacing, and mechanical malfunctions are features of the machine and would not be modified by interchanging the single elements. A combination of factors or features is involved in the identification of type-bar machines. Type size and type style lead to a general category of machine. Particular defects in a typewriter are the factors that individualize a machine. Damage or defects in the actual typeface can identify a particular machine. Alignment defects, such as a character typing "off its feet," vertically misaligned, horizontally misaligned, or twisted on its axis, are individual features of a type-bar typewriter that can be used to identify a particular machine. Other mechanical problems of a machine such as paper slippage, skipping spaces, and improper indexing of the ribbon also can be used to identify a particular machine. These defects and mechanical failures in the same combinations between a questioned typing and what a machine produces are the features upon which identification depends. Any differences in these combinations of defects preclude the identification. It must be born in mind that some defects are transitory depending on repair and service intervals or additional damage to a machine.

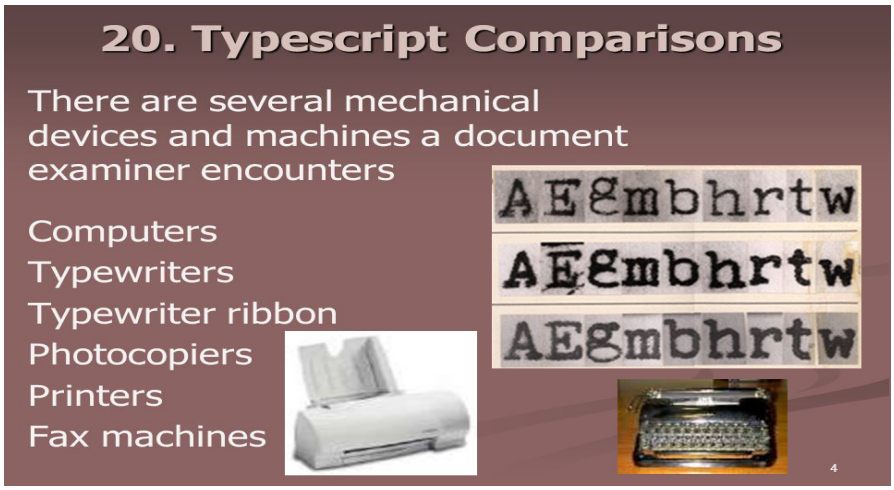
4. **Printing Processes**: Through microscopic examination, the document examiner can easily distinguish the differences between printing processes. Offset lithography, letterpress, screen-printing, intaglio, thermal, or laser printed processes all have distinguishable characteristics that identify the process used to produce the document. Each of these processes has identifiable characteristics that can be distinguished under microscopic examination. Defects in these processes can be traced back to the source; a flaw in an offset plate can be traced to that plate just as a fingerprint can be linked to a person. If defects on the plate were removed, identifying marks from these corrections, absence of background, or remnants Forensic Document Examination. A different daisy wheel was used to type the questioned document or something from the original image not completely removed from the plate would be features for which to look.

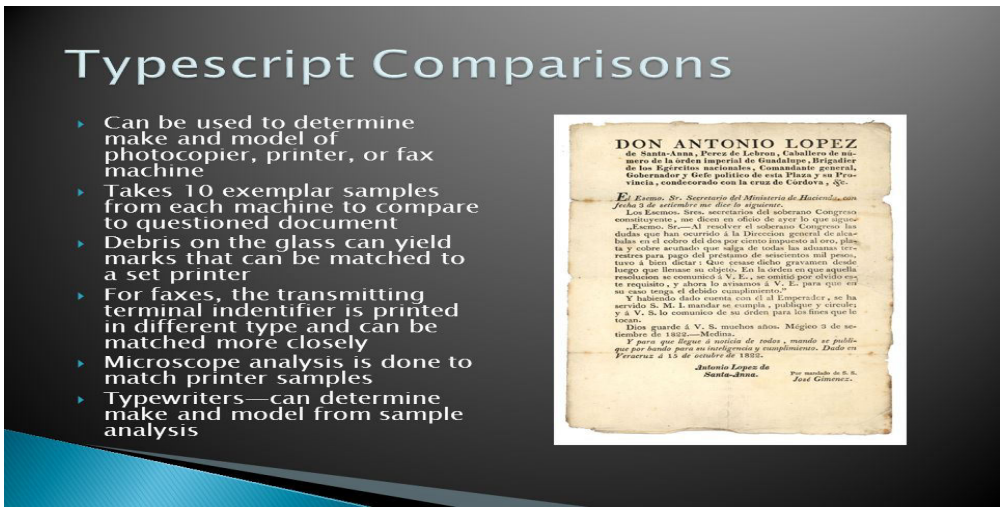
5. **Computer-Generated Documents**: Xerographic or laser printed processes, dye sublimation, dot matrix, and ink jet all have distinguishable characteristics that identify the process used to produce the document. Each of these processes also has identifiable characteristics that can be distinguished under microscopic examination. Defects in these processes can also be traced to a source; a bent pin in a dot matrix printer or damaged/clogged jets in an inkjet will leave identifiable characteristics on the printout that can be traced to that machine. Bent and non-functioning pins and jets that leave a repeated pattern on the document would be of identifying value. The pin and jet configuration can be a class characteristic, identifying a brand of machine or even a model. Drum defects on a laser printer that appear on the prints can identify the products from that particular machine. Maintenance, repair, and cleaning can make these defects transitory. This, however, can serve to date a document coming from a machine by comparing the defects in prints produced on relative dates before, during, or after maintenance. Trash marks on documents resulting from defects in the machine can be traced back to the machine. Defects in the transport system, rollers, fusers, and drum that impart individual markings to the document can be of identifying value. Analysis of the toners and ink jet inks may serve to identify a class characteristic feature indicating the manufacture and model of a printer. Colour ink jet ink can be traced and even dated based on analysis of the ink. By sampling the ink from an ink jet printed document, that document can be associated with the make and model of printer producing the document. Some analysis of the ink can be accomplished by non-destructive means without taking samples from the documents. Photocopy manipulations of a signature use model signatures that can be identified to the exact model signature if available. A computer manipulation will also use a model signature, but computer software can be used to add variation to the manipulated signature and thus foil the attempt to identify the exact model signature. When examining the original document, there will be no indentation of the writing instrument coinciding with the ink line. Also, through microscopic examination an original ink can easily be distinguished from fused toner as found in the copy process and laser printed documents. The ink jet process will also be revealed under microscopic examination if that type of printer was used in the manipulation. 244 Leaver Another manipulation by computer is the problem of reinsertions. Lines of text can be added to a legitimate document by typing text into the computer, reinserting the document into the printer, and printing the new text onto a blank portion of the document. It is not impossible, but highly unlikely, that the added text will fit the document at exactly the same line spacing and margins that already exist on the document. The added text may appear to fit on casual inspection, but magnification and measurement reveal the reinsertion.

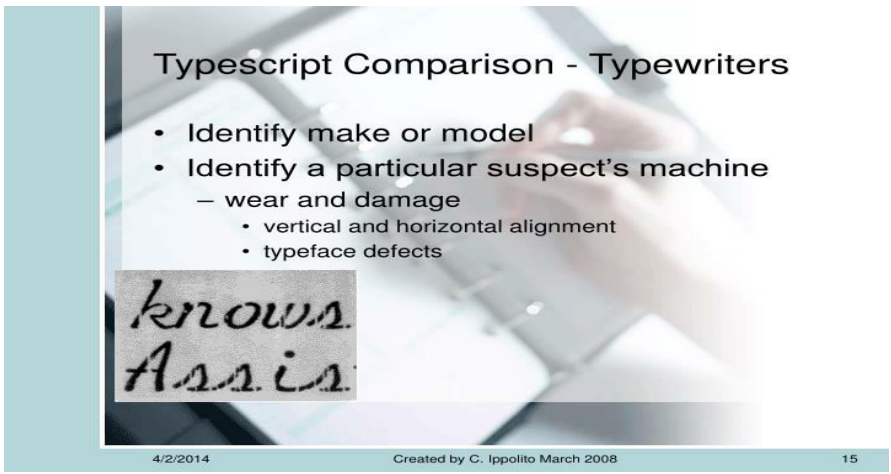
TYPEWRITERS

The evolution of the typewriter is part of the ongoing history of the human need to communicate. The development of the typewriter was the result of a desire both to speed up this process and to produce an aid for the blind in reading and writing. Gradually a machine emerged that revolutionised the work of the writer. Painstaking tasks that were normally carried out by hand could be carried out in minutes on the machine, leaving time to enjoy the 'finer things in life'. As the first Remington adverts declared; 'To save time is to lengthen life.' Unlike the telephone or the automobile, the invention of the typewriter has never received worldwide acclaim. This may be because the product is one associated with work rather than social life. Initially typewriters were slow sellers. When first shown to the public at an industrial fair, the machines attracted little interest, unlike the newly invented telephone, which received international attention. One reason given was that many professionals felt typing would appear rude to potential clients, as there would be no personal touch.

Typewritten and machine-printed documents: Documents created on a typewriter or printed with ink jet, laser printers, fax machines and photocopiers may be sourced to a particular make or model, or even to a specific machine. The printing process used to prepare documents can also be identified. When possible, the examiner should obtain known standards and any available accessories from the machine in question and the machine itself should be submitted for examination.





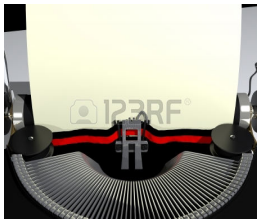


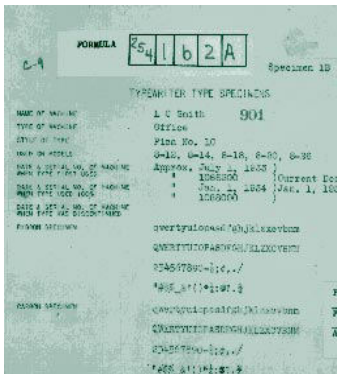
PRELIMINARY EXAMINATION OF TYPESCRIPT DOCUMENTS:

1) Number of pages.

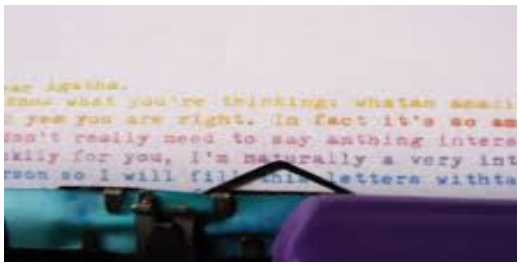
2) Colour of the pages : Check quality of all the paper/pages is same or not. The type of examinations performed on paper include thickness, weight, color, opacity, fluorescence, physical characteristics, watermarks (date of changes and dating codes), fiber content, pulping process, the relative proportion of different fibers and origin of those fibers, and chemical analysis for trace elements. The Technical Association of the Pulp and Paper Industry and the American Society of Testing Materials have standard methods for examining paper. Edge cut characteristics from cutting equipment on commercially produced paper can result in matching a page to adjacent pages. Is there any mark on the pages or not. Other physical

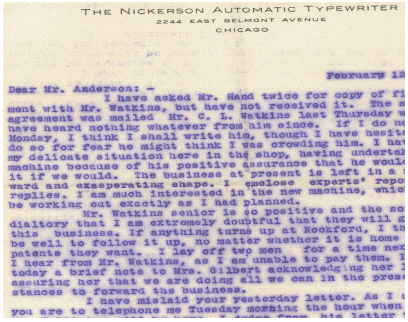
characteristics, such as creases, crinkling, indentations, and defects, can be used to source pages to a common source.





3) Color of ink: The examination of ink by the forensic document examiner is usually accomplished by the non-destructive examination of ink. This would include examination of ink using dichroic filters, Alternating Light Sources, equipment to observe the reaction of ink under infrared absorption, infrared reflectance, infrared luminescence and ultraviolet light. These examinations will reveal whether different inks may have been used to write or alter portions of a document, but will not make a determination that two or more inks are the same. To determine if two inks are the same, a qualified ink chemist should perform the testing. A few forensic document examiners are also qualified as forensic ink chemists. The procedures used to chemically distinguish inks are destructive to the document. Samples of the ink and paper are removed from the document for testing. The ink differentiation performed by most document examiners is non-destructive, but may not be conclusive. The non-destructive examination may separate inks as being different but cannot determine if the inks are the same. Additionally, non-destructive testing may not distinguish between two inks that are indeed different but do not react differently under testing. Many criminalists and ink chemists have been examining and testing other methods of ink examination and differentiation using methods, such as Raman spectroscopy with microscope attachment, Fourier transform infrared spectroscopy (FTIR), scanning electron microscope/X-ray fluorescence spectroscopy, surface-enhanced resonance Raman spectrometry (SERRS), attenuated total reflection (ATR), and FTIR-micro transmission spectra.




THE NICKERSON AUTOMATIC TYPEWRITER
2244 EAST BELMONT AVENUE
CHICAGO

February 12

Dear Mr. Anderson: -

I have asked Mr. Hand twice for copy of fi
ment with Mr. Watkins, but have not received it. The s
agreement was mailed Mr. C. L. Watkins last Thursday w
have heard nothing whatever from him since. If I do n
Monday, I think I shall write him, though I have hesit
do so for fear he might think I was crowding him. I hav
my delicate situation here in the shop, having undertak
machine because of his positive assurance that he woul
it if we would. The business at present is left in a
ward and exasperating shape. I enclose experts' repo
replies. I am much interested in the new machine, whic
be working out exactly as I had planned.

Mr. Watkins senior is so positive and the so
dilatory that I am extremely doubtful that they will g
this business. If anything turns up at Rockford, I th
be well to follow it up, no matter whether it is home
patents they want. I lay off two men for a time nex
I hear from Mr. Watkins, as I am unable to pay them. I
today a brief note to Mrs. Gilbert acknowledging her
assuring her that we are doing all we can in the presen
stances to forward the business.

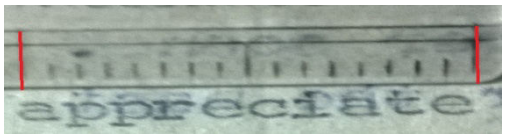
I have mislaid your yesterday letter. As I
you are to telephone me Tuesday morning the hour when

SECONDARY EXAMINATION:

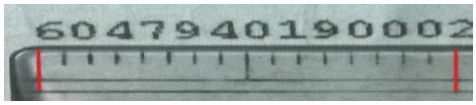
1) Make and Model

A) Size of the letters

- PICA-10 Letters per inch

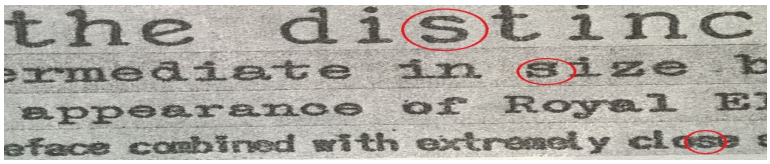


- ELITE- 12 Letters per inch



B) Design of the letters

- Design of the letters, digits and punctuation signs vary with different makes and models.
- Presence of serifs and san serifs

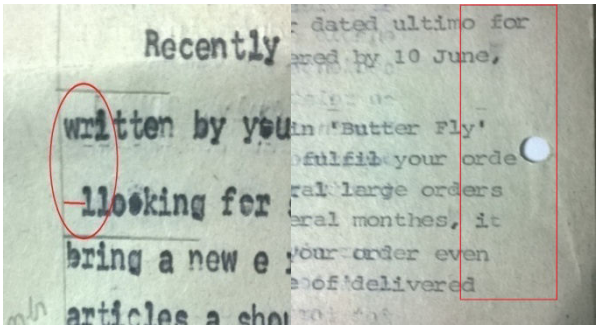


Different design of letter showing Serif and San serif

- Crispy and fuzzy typing.

2) MARGINAL DEFECTS

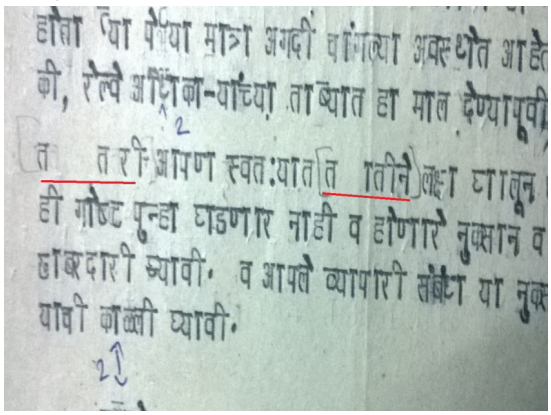
- Defects in left hand or right hand margin due to defect in the margin stop of a machine.
- Important when sheet having been removed from the machine and then replaced for further typing.



Right margin Left margin

3) Space Variations:

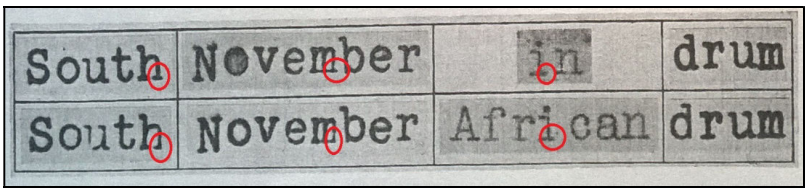
- Slippage and skippage, improper working of the ribbon gadget, improper working of space key



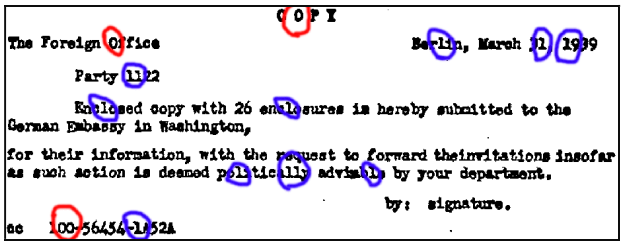
4) Typeface Defect

Breaking, chipping, denting and twisting of typefaces

a) Defects in serifs



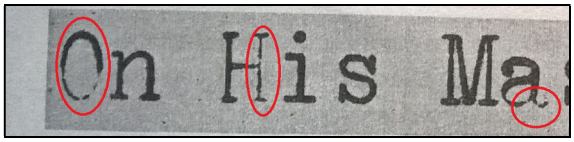
b) Missing characters



c) Uneven impression

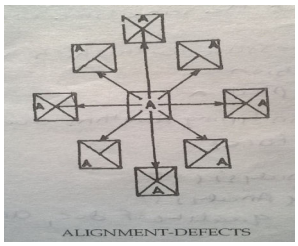
i) Vertical unevenness of impression

ii) Lateral unevenness of impression

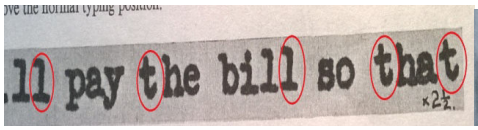


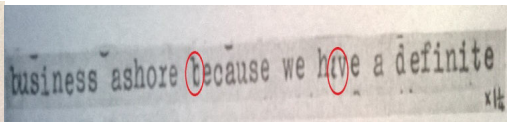
5) Alighnment Defect

Detected by microscopic examination and magnified photographs

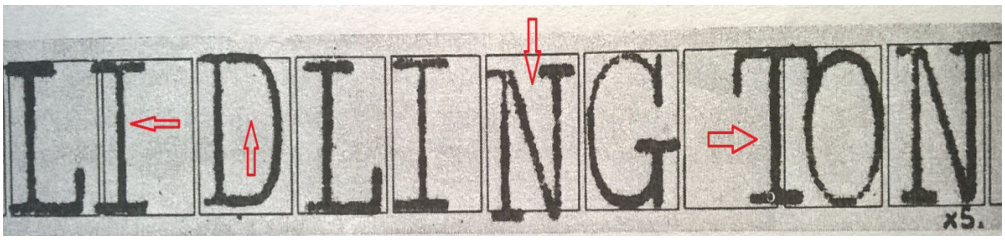


Possibility of alignment defect





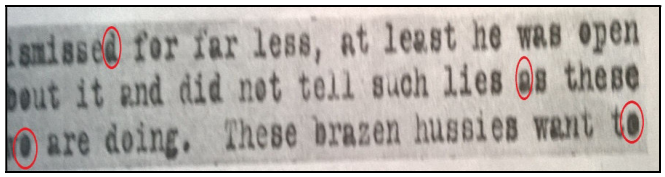
Slope misalignment Deliberate misalignment



Horizontal and vertical misalignment

6) Temporary Defects

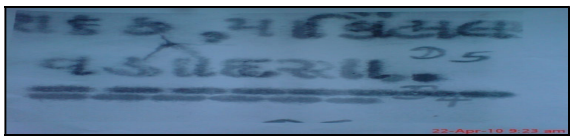
- Defective ribbon, clogged type-faces and rusty and dirty bars introduce certain identifying features.

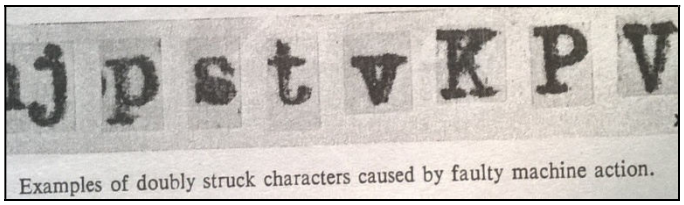


Clogged Typefaces

7) Other Faults in Typescript

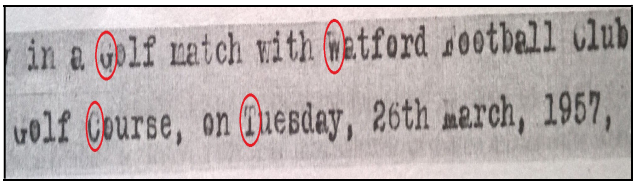
i) Double impression or rebounding



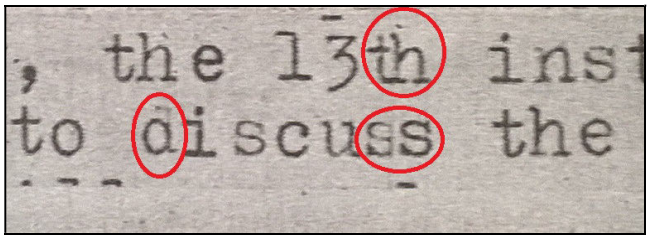


Examples of doubly struck characters caused by faulty machine action.

ii) Faulty operation of machine



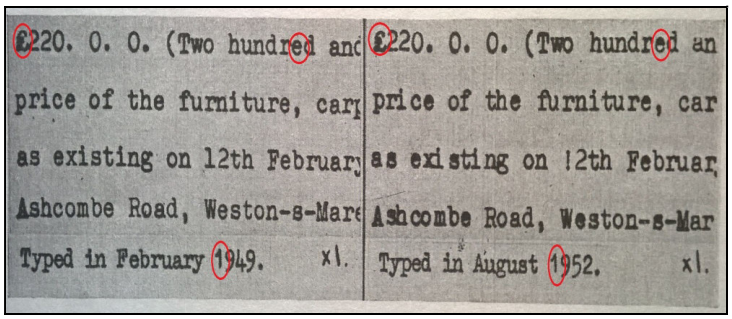
Faulty capital shift key



Faulty type bar Faulty space key

AGE OF TYPESCRIPT

- Determined form the progressive increase in the typeface defects consequent upon its continued use.
- dated typescript
- Ink analysis
- Detection- microscopic examination and VSC



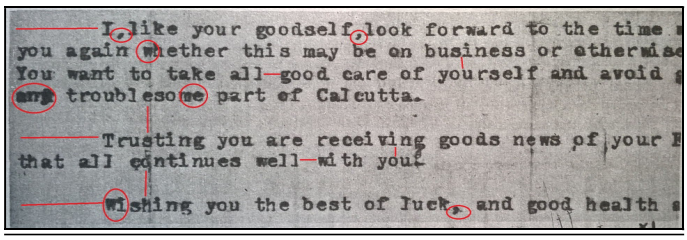
Document type on a same typewriter with different interval of time

IDENTIFICATION OF TYPIST

The following observation indicates the typist:

- Heading
- Arrangement of paragraph
- Pressure use
- Pet words & phrases, spellings

- Spacing, margins
- Alignment
- Punctuation mark
- Use of capital letters
- Length of lines
- Choice of symbols
- Techniques of correction, cancellation, overwriting.


I like your goodself look forward to the time
you again whether this may be on business or otherwise
You want to take all good care of yourself and avoid
any troublesome part of Calcutta.

Trusting you are receiving goods news of your
that all continues well with you.

Wishing you the best of luck and good health

ALTERATIONS

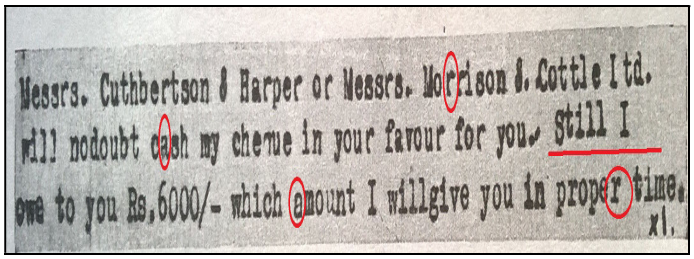
Detecting alterations, obliterations, erasures and page substitutions is an important part of document examination. Alterations, obliterations and erasures not visible to the human eye can often detected through use of photography and other imaging devices that utilize ultraviolet and infrared wavelengths of light. Using radiation filtered at various wavelengths, an imaging instrument such as a video spectral comparator (VSC) can reveal writing that has been added with a different ink, or has been altered or removed by exploiting variations in the way different inks respond to different wavelengths of light. For example, under certain light sources combined with an infrared filter, a document containing information written in ink that has faded over time may be enhanced or processed to appear darker and therefore more legible. Obliterated note viewed with visible light. Same note viewed with infrared radiation.

Obliterations: Obliterations made by ink may best be examined by infrared examination or ALS. The obliterated ink and the obliterating ink may have different infrared absorption or luminescent properties. The obliterating ink may “disappear” under infrared absorption, but if not, the obliterated ink may luminescence through the obliterating ink or through the paper from the reverse side of the paper. Other methods that may reveal the obliteration are oblique lighting, computer image enhancement, and examining reverse side embossing. Something as simple as specular reflectance may work when all the other methods do not. Some of the same methods may be used on opaquing substance and correction fluid obliterations. Transmitted light passed through the document may reveal the original writing/markings. Substances that temporarily render the correction fluid translucent may allow the examiner to decipher the markings underneath.

ADDITIONS

- Can be identified by difference in typefaces
- Change in margin
- Change in spacing of the words and lines
- Change in alignment even if same typewriter is used
- Change in ribbon ink

Detected by microscopic examination, VSC, projectina comparator


Messrs. Cuthbertson & Harper or Messrs. Morrison & Cottle Ltd.
will nodoubt cash my cheque in your favour for you. Still I
owe to you Rs.6000/- which amount I willgive you in proper time.
xl.

Change in alignment

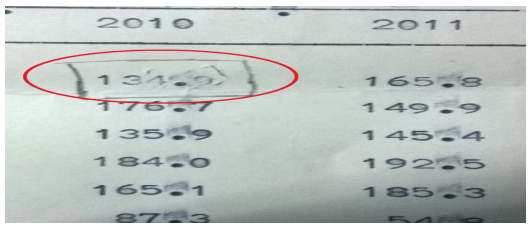
ERASURES

Oblique lighting and infrared examination have been the standard methods to decipher erasures and determine the content of the erasure. Computer image enhancement has been advantageous in visualizing the erased text. Recently, it has been demonstrated that certain scanning software may reveal the erased text. When scanned into a computer, writing that has been completely erased, at least that is no longer visible to the naked eye, can sometimes be visible on the scanned image.

- Paper fibers are disturbed.
- Presence of residual impression

Detected by lightning the document, residual impression may help to decipher the letters

- capital letters and wide characters (m,w)- vanished without trace
- with small outlines such as “l” and “i”, and punctuation marks in particular- deeply impressed that recognizable traces remain.



Disturbed paper fiber

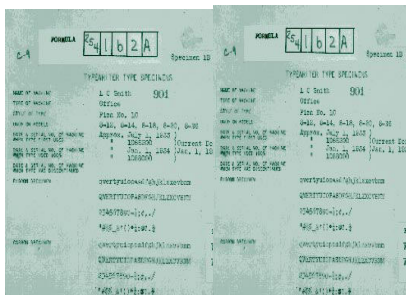
METHODS AND EUIPMENTS USED FOR COMPARISON OF TYPESCRIPT

The basic equipment for a document examiner to begin with is a variety of magnifiers, a good quality stereoscopic microscope, and various light sources

including a light table, photographic filters, and diachronic filters. Also included in this basic equipment should be a good quality camera. It could be a standard 35 mm with a normal lens and a macro lens, but a good digital camera may be better owing to modern computers. Images can be downloaded into photo software for recording, storing, tilting, and enhancement of captured images. A scanner can also be used to import images and record them for use. A lightweight scanner can be taken on scene for the collection of images as easily as a camera. This of course implies that a computer should be part of the equipment along with a good quality printer. The advent of all these impressive capturing and storage devices still does not preclude the need for examining the original document under various lighting techniques. The type of examinations that can be performed in a document laboratory should not be limited with only the previously mentioned equipments. A complete document laboratory should include an electrostatic detection apparatus (ESDA) and a video spectral analyzer (VSC) or similar equipment.

1) Side By Side Comparison

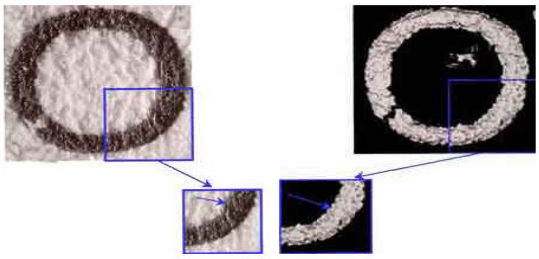
- Manual method



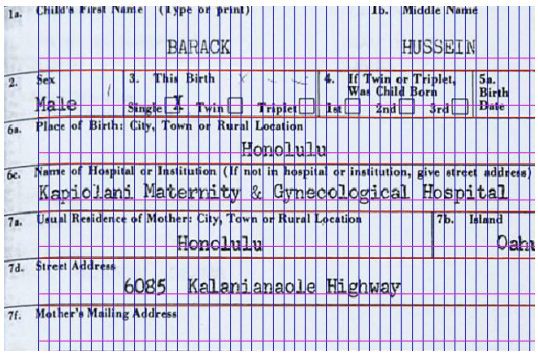
- Comparison microscope

2) Projectina Comparator

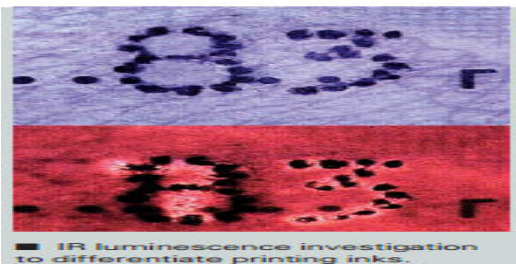
Docucenter 4500



3) Grid Method



4) Video Spectral Comparator



CONCLUSION

Typescript plays an important role in case of any legal documents. And their examination may help to provide identification of particular typewriter, age of typescript, identification of typist. If there are any alterations done in the document.

REFERENCES

- B.R.Sharma. (2003). *Forensic science in criminal investigation and trials 5th addition.* Universal law publishing,New Delhi.

- Ellen, D. (2006). *Scientific Examination of Documents: Methods and Techniques, Third Edition.* Boca Raton: CRC group, Taylor and Francis group.
- Harrison, W. R. (1958). *Suspect Documents: Their Scientific Examination.* Nelson-Hall.
- Koppenhaver, K. M. (2007). *Forensic Document Examination: Principles and Practice.* New Jersey: Humana press inc.
- Leaver WL, Smith JW. Using an alternate light source to restore writing. J Forensic Sci 1999;44:653–655.
- Huber RA, Headrick AM. Handwriting Identification: Facts and Fundamentals. Boca Raton, FL, CRC Press, 1999, p. 29.
- Kam M, Gummadidala K, Fielding G, Conn R. Signature authentication by forensic document examiners. J Forensic Sci 2001;46:884–888.
- Sita J, Found B, Rogers DK. Forensic handwriting examiners' of signature comparison. J Forensic Sci 2002;47:117–1124.

LESSON NO.2.4

AUTHOR : S. Jaswinder Singh

Charred Documents

Content

- **Introduction**
- **Definition of charred documents**
- **Handling of charred documents**
- **Stabilization methods of charred documents**
- **Examination and Decipherment of charred documents**
- **Queries related to the charred documents**
- **Suggested Questions**
- **References**

Introduction:

Sometimes the charred document become a vital source to solve crimes as such cases can be of bank frauds, cash transactions, previous vital records can be burnt to escape from being caught after committing some fraud.

Documents are set to fire with intention to destroy such records which is an easy way to destruction and it can be shown as accidental fire. Such records or documents which are partially burnt can be deciphered if properly handled, preserved and analyzed.

Definition:

Charred document is a document that has become blackened and brittle through burning or through exposure to excessive heat. The exposure to excessive heat and temperature make the paper brittle which readily breaks up when handled.

The characteristics of the charred documents are as follows: -

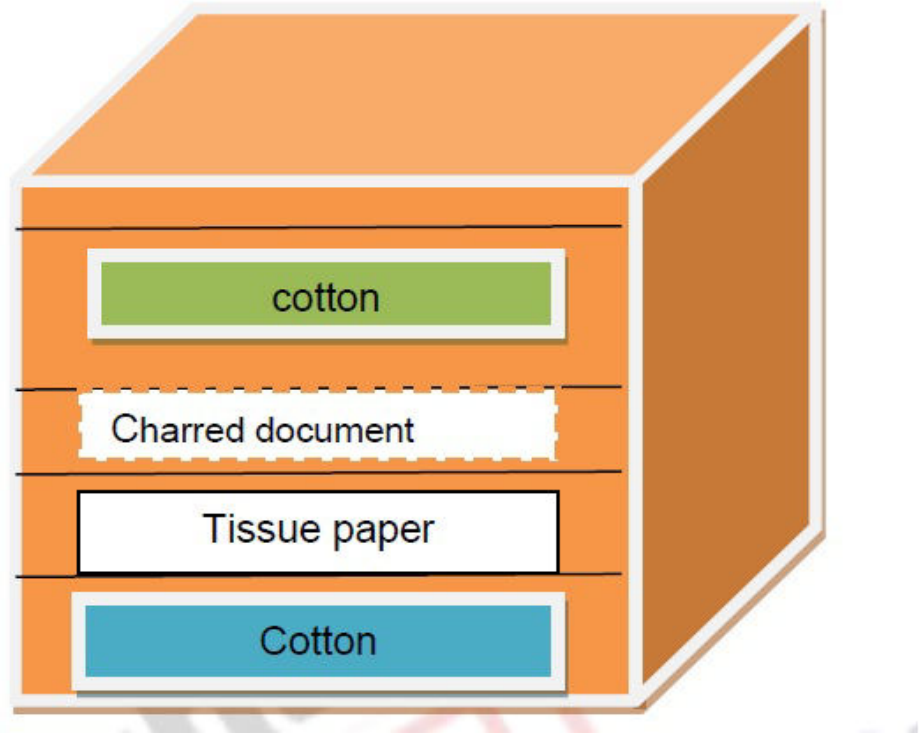
1. The documents become black due to heat.
2. The edges of the documents become curled.
3. The document becomes fragile.
4. Due to the fragility developed the document may break into pieces even by a small amount of pressure.
5. The charred document always have a point during its burning period at which the written material is clearly seen and at that time the photograph of the document should be taken if possible.

Kit used for collection of such evidence

Kit should contain following essentials for collection of charred document.

- Forceps
- Spatula
- Card-Board Box
- 2-3% Polyvinyl Solution in Acetone
- Cotton
- Corrugated Box
- Thin Glass Sheet
- Sprayer
- High Intensity Light Source
- High Resolution Camera
- Marking Pens

- Humidifiers
- Dehydrator
- Plastic tapes



Diagrammatic representation of corrugated box

Handling of charred documents:

Charred document has little tensile strength so that no attempt should be made to lift it with tweezers, instead the charred mass should be moved by first insinuating a sheet of stiff paper beneath it and drawing the paper sheet with the charred paper to a stiff sheet of card-board or metal. The whole should be transferred to a box.

When possible, the charred document should be moved in the container in which they are found. If the fragments are not packed tightly, light weight absorbent cotton may be used as padding.

No attempt should be made to unfold the burnt papers or to flatten curled sheets.

Decipherment of a charred document that has been shattered into small fragments is almost impossible. Therefore every precaution must be taken in handling and transporting the charred residue in order to prevent the large pieces from becoming badly broken.

Stabilization of charred documents:

Suitable binders should be used for stabilizing the charred documents. Following are the suitable stabilizing agents

1. **Dilute gelatin solution**
2. **Gum Arabic**
3. **Dilute solution of cellulose acetate in acetone**
4. **3% solution of polyvinyl acetate**

These above mentioned stabilizing agents are used to protect the charred documents so that it can be taken to laboratory.

Effect of temperature on writing

S No.	*Temperature at which the paper was burnt (°C)*	*Colour of charred paper*	*Visibility of charred writing*
1.	90	Brown	Legible
2.	280	Black	Invisible
3.	350	Grey	Visible
4.	400	Cream-White	Visible

Examination and Decipherment of charred documents:

1. Photographic decipherment of a charred document:

A recent charred paper is placed between two unexposed photographic plates. The two are then tightly bound together to assume tight contact them and stored away in a light tight container for about 15 days. At the end of this time the plates are unwrapped and developed in normal way producing a photographic negative of the original material.

2. Chemical Methods:

Chloral hydrate solution or **a mixture of glycerine and alcohol** can be used to decipher handwriting in a charred document.

Advantage: time saving.

Disadvantage: Results are uncertain.

3. Photographic method:

Photography by UV, IR and Oblique/ reflected light is also useful in some cases.

Queries related to the charred documents which can be asked from Questioned Document Experts

Such queries can vary from case to case.

(i) To detect and decipher the text of the charred documents.

(ii) Is there any signature on the charred document? If yes, can it be identified?

(iii) Whether the document contains handwriting/printed or typed matter.

(iv) Whether the charred mass is a currency paper or ordinary paper.
(v) What is the size and colour of the burnt documents.
(vi) Whether the paper of the charred document is same as that of partially burned document.
(vii) Any other observation related to the case.

Note: Specific queries would depend upon the nature of the crime and exhibits seized at crime scene.

Suggested Questions

1. What are charred documents?
2. How the charred documents are handled during packing and transportation?
3. Explain the methods to analyze the charred documents.

References

1. Albert S. Osborn, *Questioned Documents*, 2nd edn., Delhi,1998.
2. Ellen Ellen, *Questioned Documents-Scientific Examination*, Washington, 1991.
3. Jan Seaman Kelly & Brian S. Lindblom, *Scientific Examination of Questioned Document*, London, 2006.
4. Ordway Hilton, *Scientific Examination of Questioned Document*, New York, 1982.
5. R.E. Jacobson , S.F. Ray, G.G. Attridge, N.R. Oxford, *The Manual of Photography-Photography and Digital Imaging*, 9th edn, UK, 2000.
6. Wilson R. Harrison, *Suspect Documents: Their Scientific Examination*, Delhi Indian Reprint, 2001.
7. Roy A. Huber & A.M. Headrick, *Handwriting Identification: Facts and Fundamentals*, Washington D.C., 2000.
8. Ron N. Morris, *Forensic Handwriting Identification: Fundamental Concepts and Principles,* New York, 2001.
9. Katherine M. Koppenhaver, *CDE, Forensic Document Examination: Principles and Practise*, New Jersey, 2007.
10. R.B. Sharma, *Forensic Science in Criminal Investigation and Trials*, 4th edn, New Delhi, 1999.
11. A.K. Bapuly, *Forensic Science*: *Its Application in Crime Investigation*, 1st edn, Hyderabad, 2006.

Tools and techniques used in Questioned Documents Examination

Document: Any material that contains marks, symbol or signs either visible, partially visible or invisible that may ultimately convey a meaning or a message to someone.

E.g. Any material written on paper either by typewriter or printer or by hand, signs painted on walls, writing written on wood/ windows/ walls/ stones/ mirror etc.

Questioned Document: The document which is suspected of being fraudulent or whose source is unknown and background is disputed is known as Questioned Document.

Such documents are also referred as **Disputed Documents or Suspected Documents.**

CLASSES OF QUESTIONED DOCUMENTS (Refer chapter 1)

Types of problems

- Determination of Age of document.
- To identify alterations in documents
  - Erasure
  - Additions
  - Obliteration
- Secret writing
- Charred document
- Examination of paper, ink and other writing material.
- Identification of handwriting and signatures (forgery, ransom case).
- Identification of typewriting and printed matters.
- To identify counterfeited currency notes etc.

To solve the above mentioned problems related to the questioned documents, the examination of such document is must.

It is a process which has to go step-by-step.

Preliminary Examination of Questioned Documents

- A document is usually questioned for its origin, contents or the circumference regarding its production.

- It includes examination of paper, ink, typed matter, printed matter, water mark, and all other elements forming the document.

The tools required for preliminary examination of questioned documents require

- Magnifying glass
- A set of comfortable chair & table
- Good light source
- Patience and
- A healthy suspicious mind which doesn't accept the things as they are.

Some basic points that should be considered for the preliminary examination of documents are :-

1. Odour
2. Folds and Creases
3. Impression
4. Cancellation Stamps
5. Typescript
6. Presence of secret writings
7. Extraneous marks
8. Ink lines
9. Signatures
10. Stamps

Different tools and techniques are used for analyzing different problems related to the documents and that too depends on the availability of tools and techniques.

Basic techniques widely used for document examination are:

1. Oblique light (grazing angle) can be used for detection of
    - Indented writings
    - Erasures
    - Currency examination
2. Transmitted light can be used for detection of
    - Forgery
    - Secret writings
    - Erasures (Chemical & Mechanical)
    - Water marks etc.
3. UV light can be used for detection of
    - Secret writings
    - Obliterations
    - Additions
    - Deletions
    - Erasures (Chemical)

- Currency examination
- Sheet Insertion

4. Infrared light can be used for analysis of
   - Over-writings
   - Obliterations
   - Alterations in lottery numbers
5. Instrumental Techniques
   1. Stereo Microscope
   2. Electro Static Detection Apparatus (ESDA)
   3. Video Spectral Comparator (VSC)
   4. Electron Microscope
   5. Thin Layer Chromatography (TLC)

1. STEREO MICROSCOPE

A stereo model is an optical microscope that functions at a low magnification.

It works by using two objectives and two eyepieces provide the eyes with slightly different viewing angles. In essence, the left and right eye are seeing the same object but in a different way.

Much like what happens with your actual eyes, these two separate viewing angles yield a three-dimensional image. This feature makes it ideal for examining surfaces of solid materials.

Stereo Microscope in Questioned Documents Examination

Stereomicroscope is widely used by the QDEs for deciphering:

1. Indented Writings
2. Intersecting strokes of various writing instruments
3. Detection of forgery
4. Detection of erasures
5. Seepage of ink into paper
6. Detection writings over paper folds

2. ESDA: Electro Static Detection Apparatus

An Electro Static Detection Apparatus is used to visualize indentations by applying an electrostatic charge to a transparent film. The film is laid across the page in question and once the charge has been applied, black toner is passed across the film and reveals any indentations.

Parts of ESDA:

- Bronze platen
- Corona
- Electrostatic current Unit (7kV)
- Mylar sheet
- Black toner

ADVANTAGES OF ESDA

- Non-destructive technique
- Invisible indented writings can be made visible for further analysis.
- Permits the fast and routine examination of all suspect documents.
- Give reliable results.
- It is extremely sensitive that means indentations found up to 7 sheets below the page where the original writing was made may be visualized.
- If ESDA is unable to visualize the writing then it allows other techniques to be applied.

DISADVANTAGES OF ESDA

It is not suitable for the examination of loose paper such as newspaper or very glossy such as magazine covers.

If a document gets wet by any liquid, it will completely destroy the ESDA impressions.

3. VSC: Video Spectral Comparator

A Video Spectral Comparator is used to analyze inks and see whether they are the same or different. This is done by looking at them under different lighting conditions where some wavelengths of light are blocked. This technique can uncover layers in documents where words have been scribbled out or written over

APPLICATIONS OF VSC

1. **Banks: Currency forgery has always been an issue of concern for the banks.**

Fraudsters are finding new ways to produce fake currency. Banks have started using VSC to monitor currency in circulation and spot the fake ones. With VSC each security feature of bank notes can be observed like ink, images, paper gradient and security thread. It can be used to examine suspected fake cheques.

2. **Government Offices: A growing concern these days is fake official documents.**

Fraudsters create fake certificates, notarized documents, license agreements, degree certificates, birth certificates, etc. VSC can be very useful to examine such documents and establish authenticity. It can detect alterations made to original documents.

3. **Airport: VSC is used to examine passport and visa documents at airports.**

Examination of documents under high magnification can quickly reveal evidence of tampering.

4. **Forensic Examination: VSC is one the most used tool in questioned document** analysis.

With its wide array of features it saves a lot of time and produces accurate results. Objects such as currency, stamps, certificates, legal documents, artwork, and identification cards can be examined with the help of Video Spectral Comparator.

ADVANTAGES OF VSC:

1. Whether a document has been completed using one or more than one ink.
2. Whether any alterations have been made to a document - such as changing a date or altering an amount.
3. What is present underneath an obliterated entry - the obliteration could have been made by scribbling over with a pen or by using correction fluid.
4. The sequence in which intersecting lines have been written. This can be useful, for example, in determining whether one signature was added before or after another one.
5. Under advantageous conditions, the text of a pencil entry that has been subsequently erased.
6. Problems involving typewriting, computer printouts, photocopies.
7. Problems involving with plastic currency, cheques, passports etc.

EXAMPLE : Examination of Passport

4. Electron Microscope

Electron Microscopes are scientific instruments that use a beam of highly energetic electrons to examine objects on a very fine scale.

Electron beam also follows the properties like light radiation. Hence, the electron beam can be used in microscopy in place of light. This examination can yield information about the surface features of an object, shape and size of the particles, composition and structure of various samples.

Schematic diagram of electron microscope

APPLICATIONS OF ELECTRON MICROSCOPY

Due to its superior performance, Electron Microscopy is used in a lot of Forensic laboratories for

1. Gunshot residue analysis
2. Firearms identification (bullet markings comparison)
3. Investigation of gemstones and jewellery
4. Examination of paint particles and fibres
5. Filament bulb investigations at traffic accidents
6. Handwriting and print examination / forgery
7. Counterfeit bank notes
8. Trace comparison
9. Ink Analysis
10. High resolution surface imaging

5. TLC: Thin Layer Chromatography

DEFINITION: TLC is a technique which is used for the separation of various components of a sample between two phases. One is stationary and other is mobile. The separation of components takes place on basis of relative affinities.

TYPES OF CHROMATOGRAPHY

- Solid-liquid chromatography. Examples TLC, Paper chromatography, HPLC, HPTLC, Ion-Exchange.
- Liquid-Liquid Chromatography
- Gas-Liquid chromatography
- Gas Solid chromatography

STATIONARY PHASE

A) Silica Gel G: It is weakly acidic in nature. It is probably that popular TLC adsorbent when calcium sulphate is used as a binder the plates are termed as silica Gel G. The plates have uniform distribution of particle size normally about 20µm in diameter.

B) Alumina: it is weakly basic adsorbent.

C) Kieslguhr: This is natural occurring amorphous silica acid from the skeletons of diameter of often refereed to as diatomaceous earth.

D) Magnesium Silicate: This material is used only for specialized separations.

E) Cellulose: these are made up of cellulose fibers but these run much more slowly than silica plates.

MOBILE PHASE

The choice of mobile phase either a simple solvent or a mixture depend on the compounds to be separated and stationary phase to be used. When a stationary phase has been chosen solvents of increasing elution strength can be tried until a particular separation is achieved. Solvent should be cheap, easily available in pure form and should be stable in air or when mixed with acids or alkalis. It should be easily removable from the plate after chromatographic, non toxic and should not react with the substance to be separated.

TECHNIQUE

It involves different stages as follows:

- Preparation of plate
- Applying the sample
- Running the plate
- Locating the spots

TLC VISUALIZATION METHODS

1. Naked Eye

2. UV-Light
3. Iodine Fuming
4. Spraying with Chromogenic Reagents like $KMnO_4$ in H_2SO_4.

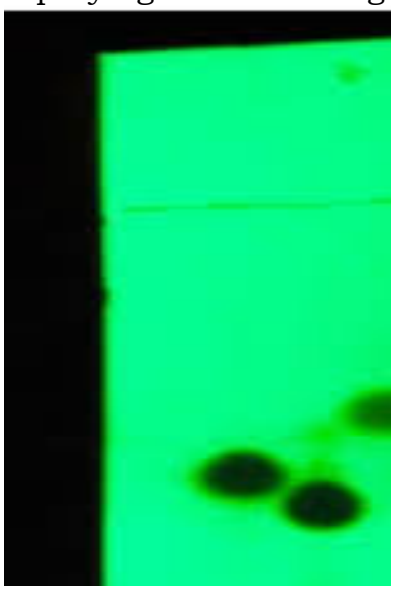


Figure showing visualization of TLC Plate under UV Light

Figure showing visualization of TLC Plate using Iodine Fuming

CALCULATING Rf VALUE

The basic chromatographic measurement of a substance in TLC is the Rf value, defined as

$$Rf = \frac{\text{Distance the substance travels from the origin}}{\text{Distance the solvent front travels from the origin}} \times 100$$

This value varies from 0 to 1. However, it is more usual to quote Rf X 100 values to avoid the use of decimals.

ADVANTAGES OF TLC

- It is not only an analytical technique but it is also a separation technique which separates 2 or more compounds present in a mixture.
- The greatest advantage of TLC is that it is used to compare ink samples (ball point pen, fountain pen etc.) under investigation.
- TLC can be performed on any scale because of its rapid speed it can be employed.
- TLC is employed with conjugation with other methods of analysis.
- Compounds which are encountered in trace amounts such as toner from a printed document, extraneous marks etc. can also be studied by TLC

Some typical questions asked from questioned document examiners:

1. Is the signature genuine?
2. Is the document forged, and if so is it forged by a particular person?
3. Is the same person the author of several documents?
4. Did someone guide a person's hand as a will was signed?
5. What is written under the crossed out portion of the writing?
6. Did the signer of the document also initial the changes?
7. Was the document written on the date indicated?
8. Are there erasures on the document?
9. Are there alterations or obliterations on the document?
10. What was originally written before the alteration or under the obliteration?
11. Are there perforations, folds, staple holes, or other physical clues on the document?
12. Was the entire document rewritten, or was it prepared sequentially, over a period of time?

PROPOSED QUESTIONS

1. Give advantages of VSC & ESDA.

2. Discuss different tools and techniques used by the experts for questioned document examination.
3. Which is the non destructive technique used by the experts for questioned documents examination? Discuss in brief?
4. What are Holographic documents?
5. Differentiate between alteration and obliteration?
6. What are standards for comparison? Give its types and need of standards for comparison.
7. Which one is better :requested or collected standards?

REFERENCES

- B.R.sahrma. (2003). *Forensic science in criminal investigation and trials 5th addition.* Universal law publishing,New Delhi.
- Ellen, D. (2006). *Scientific Examination of Documents: Methods and Techniques, Third Edition.* Boca Raton: CRC group, Taylor and Francis group.
- Harrison, W. R. (1958). *Suspect Documents: Their Scientific Examination.* Nelson-Hall.
- Koppenhaver, K. M. (2007). *Forensic Document Examination: Principles and Practice.* New Jersey: Humana press inc.
- Leaver WL, Smith JW. Using an alternate light source to restore writing. J Forensic Sci 1999;44:653–655.
- Huber RA, Headrick AM. Handwriting Identification: Facts and Fundamentals. Boca Raton, FL, CRC Press, 1999, p. 29.
- Kam M, Gummadidala K, Fielding G, Conn R. Signature authentication by forensic document examiners. J Forensic Sci 2001;46:884–888.
- Sita J, Found B, Rogers DK. Forensic handwriting examiners' of signature comparison. J Forensic Sci 2002;47:117–1124.
- Baker, J.N (1955): Law of Disputed and Forged Documents. The Michie Company, Charlottesville, Virginia.
- Osborn, A.S. (1929): Questioned Document, 2nd ed. Boyd Publishing Company, Albany, NY.
- Hilton, O (1982): Scientific Examination of Questioned Documents. Revised Ed. Elsevier Science Publishing Company, NY.
- Harrison, W.R. (1966): Suspected documents: their Scientific Examination. Sweet and Maxwell Ltd., UK.
- Saxena B.L. : Law and Technique Relating to Identification of Handwriting Disputed Documents, Finger Prints, Foot Prints and Detection of Forgeries. (Revised by Singla A.K. in Central Law Agency, Allahabad.

Type Setting by Dept. of Distance Education
Punjabi University, Patiala - 2019