Directorate of Distance Education
NALSAR University of Law, Hyderabad
&
Truth Labs, Hyderabad

Reading Material

Advanced Post Graduate Diploma

in

Criminal Law and Forensic Science

1.2.4 Introduction to Forensic Science & Forensic Physical Sciences

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FOREWORD

Phenomenal advances in Science and Technology and application of some such knowledge put to use by the criminals for illegal purposes has recently led to proliferation of cyber crimes and technology based crimes, etc. At the same time many conventional crimes are now being committed using new technologies through use of smart phones, computer software and hardware usage based on SMS messages and telephone call data, etc and these evidentiary items are acting as an essential proof for investigating many sensational crimes like rape, murder, theft, assault, burglary, cheating, etc. In the light of all that, extensive use of forensic science to unravel truth became an indispensable tool for criminal investigation and trials.

Against this backdrop, the knowledge of forensic science and its deep understanding and appreciation by all the end users viz. Police, Prosecutors, Advocates as well as the Judiciary, is paramount for ensuring peace and tranquillity in the society.

It is therefore necessary to familiarize the legal fraternity, notably the lawyers and legal officers who are one of the first respondents to be contacted by the victims and perpetrators of crime to be afforded an opportunity to get acquainted with the sociological, criminological and psychological factors that affect a normal person to commit a crime, the laws that are enacted for tackling the crime followed by investigation and Prosecution of crime as well as punishment and the roles and responsibility of the agencies that are assigned the tasks.

Similarly, it is also necessary for them to understand the technological nuances and delicate scientific intricacies involved in handling various types of evidence analyzed in different branches of forensic science by the experts of a modern forensic laboratory.

The advanced PG diploma course in Criminal Law and Forensic Science now offered from NALSAR is primarily aimed at fulfilling the above objectives and accordingly the reading materials prepared for the purpose will serve as a basic guide for understanding the fundamental concepts, processes and procedures for all those involved in handling the issues.

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Contents

UNIT I

LEARNING OBJECTIVES:

In this unit you will be introduced to:

1. The definition and difference between Forensic Science and Criminalists.

2. The major contributors to the development of Forensic Science.

3. Definition of physical evidence.

4. The various steps to be taken to thoroughly record the crime scene.

5. The various proper techniques for packaging common types of physical evidence.

6. Various steps typically required to maintain appropriate health and safety standards at the crime scene.

7. The common types of physical evidence encountered at crime scenes.

8. Differences between the identification and comparison of physical evidence.

UNIT I- HISTORY OF SCIENTIFIC INVESTIGATION

1.0 HISTORY AND DEVELOPMENT OF FORENSIC SCIENCE

Forensic science owes its origins first to the individuals who developed the principles and techniques needed to identify or compare physical evidence, and second to those who recognized the need to merge these principles into a coherent discipline that could be practically applied to a criminal justice system.

Today, many believe that Sir Arthur Conan Doyle had a considerable influence on popularizing scientific crime-detection methods through his fictional character Sherlock Holmes, who first applied the newly developing principles of serology, fingerprinting, firearms identification, and questioned-document examination long before their value was first recognized and accepted by real-life criminal investigators. Holmes's feats excited the imagination of an emerging generation of forensic scientists and criminal investigators. Even in the first Sherlock Holmes novel, *A Study in Scarlet,* published in 1887, we find examples of Doyle's uncanny ability to describe scientific methods of detection years before they were actually discovered and implemented.

For instance, here Holmes probes and recognizes the potential usefulness of forensic serology to criminal investigation:

"I've found it. I've found it, he shouted to my companion, running towards us with a test tube in his hand." I have found a reagent which is precipitated by haemoglobin and by nothing else why, man, it is the most practical medico-legal discovery for years. Don't you see that it gives us an infallible test for blood stains? The old guaiacum test was very clumsy and uncertain. So is the microscopic examination for blood corpuscles. The latter is valueless if the stains are a few hours old. Now, this appears to act as well whether the blood is old or new. Had this test been invented, there are hundreds of men now walking the earth who would long ago have paid the penalty of their crimes. Criminal cases are continually hinging upon that one point. A man is suspected of a crime months perhaps after it has been committed. His linen or clothes are examined and brownish stains discovered upon them. Are they blood stains, or rust stains, or fruit stains, or what are they? Because there was no reliable test. Now we have the Sherlock Holmes test, and there will no longer be any difficulty.

Many people can be cited for their specific contributions to the field of forensic science. The following is just a brief list of those who made the earliest contributions to formulating the disciplines that now constitute forensic science.

Mathieu Orfila (1987-1853). Orfila is considered the father of forensic toxicology. A native of Spain, he ultimately became a renowned teacher of medicine in France. In 1814, Orfila published the first scientific treatise on the detection of poisons and their effects on animals. This treatise established forensic toxicology as a legitimate scientific endeavor.

Alphonse Bertillon (1853-1914). Bertillon devised the first scientific system of personal identification. In 1879, Bertillon began to develop the science of *anthropometry*, a systematic procedure of taking a series of body measurements as a means of

distinguishing one individual from another. For nearly two decades, this system was considered the most accurate method of personal identification. Although anthropometry was eventually replaced by fingerprinting in the early 1900s, Bertillon's early efforts have earned him the distinction of being known as the father of criminal identification.

Francis Galton (1822-1911). Galton undertook the first definitive study of fingerprints and developed a methodology of classifying them for filing. In 1892, he published a book titled *Finger Prints,* which contained the first statistical proof supporting the uniqueness of his method of personal identification. His work went on to describe the basic principles that form the present system of identification by fingerprints.

Leone Lattes (1987-1954). In 1901, Dr. Karl Landsteiner discovered that blood can be grouped into different categories. These blood groups or types are now recognized as A, B, AB, and O. The possibility that blood grouping could be a useful characteristics for the identification of an individual intrigued Dr. Lattes, a professor at the Institute of Forensic Medicine at the University of Turin in Italy. In 1915, he devised a relatively simple procedure for determining the blood group of a dried bloodstain, a technique that he immediately applied to criminal investigations.

Calvin Goddard (1891-1955). To determine whether a particular gun has fired a bullet requires a comparison of the bullet with one that has been test-fired from the suspect's weapon. Goddard, a U.S. Army colonel, refined the techniques of such an examination by using the comparison microscope. Goddard's expertise established the comparison microscope as the indispensable tool of the modern firearms examiner.

Albert S. Osborn (1858-1946). Osborn's development of the fundamental principles of document examination was responsible for the acceptance of documents as scientific evidence by the courts. In 1910, Osborn authored the first significant text in this field, *Questioned Documents.* This book is still considered a primary reference for document examiners.

Walter C. McCrone (1916-2002). Dr. McCrone's career paralleled startling advances in sophisticated analytical technology. Nevertheless, during his lifetime McCrone became the work's preeminent microscopist. Through his books, journal publications, and research institute, McCrone was a tireless advocate for applying microscopy to analytical problems, particularly forensic science cases. McCroneÊs exceptional communication skills made him a much-sought- after instructor, and he was responsible for educating thousands of forensic scientists throughout the world in the application of microscopic techniques. Dr. McCrone used microscopy, often in conjunction with other analytical methodologies, to examine evidence in thousands of criminal and civil cases throughout a long and illustrious career.

Edmond Locard (1877-1966). Although Gross was a strong advocate of the use of the scientific method in criminal investigation, he did not make any specific technical contributions to this philosophy. Locard, a Frenchman, demonstrated how the principles enunciated by Gross could be incorporated within a workable crime laboratory. Locard's formal education was in both medicine and law. In 1910, he persuaded the Lyons police department to give him two attic rooms and two assistants to start a police laboratory.

During Locard's first years of work, the only available instruments were a microscope and a rudimentary spectrometer. However, his enthusiasm quickly overcame the technical and monetary deficiencies he encountered. From these modest beginnings, Locard's research and accomplishments became known throughout the world by forensic scientists and criminal investigators. Eventually he became the founder and director of the Institute of Criminalistics at the University of Lyons; this quickly developed into a leading international center for study and research in forensic science.

Locard believed that when a person comes in contact with an object or person, a cross-transfer of materials occurs (Locard's exchange principle). Locard maintained that every criminal can be connected to a crime by dust particles carried from the crime scene. This concept was reinforced by a series of successful and well-publicized investigations. In one case, presented with counterfeit coins and the names of three suspects, Locard urged the police to bring the suspect's clothing to his lab. On careful examination, he located small metallic particles and coins were composed of exactly the same metallic elements. Confronted with this evidence, the suspects were arrested and soon confessed to the crime. After World War I, Locard's successes served as an impetus for the formation of police labs in Vienna, Berlin, Sweden, Finland and Holland.

1.1 DEVELOPMENT OF FORENSIC SCIENCE IN INDIA

The application of science and technology to the detection and investigation of crime and administration of justice is not new to India. Although our ancestors did not know forensic science in its present form, scientific methods in one way or the other seem to have been followed in the investigation of crime. Its detailed reference is found in Kautilya's 'Arthashastra', which was written about 2300 years ago. The discipline of crime scene investigation developed mostly in the second half of the nineteenth century. Sir Arthur Conan Doyle's Sherlock Holmes is often credited as the fictional father of Criminalistics, using methods in Criminalistics long before the science was recognised and accepted.

Anthropometric Bureau

In 1878 Alphonse Bertillon initiated a system of classification called anthropometry for personal identification, an elaborate system of recording a convicted criminalÊs body measurements for identification purposes. With the introduction of Photography, the Criminal Investigation Department (CID) maintained records of every known criminal including a detailed description of his appearance. With the aid of Bertillon's anthropometric system India adapted the Bertillon's system of personnel identification. Thus an Anthropometric Bureau was established in 1892 at Calcutta for maintaining anthropometric records of criminals.

Fingerprint bureau

William Herschel applied his knowledge and skill in devising a system of registration of finger or thumb impressions to safeguard the interests of the government. This registration procedure extended to prison regulations for identifying convicted criminals. In 1891 Edward Richard Henry introduced the thumb impressions in the record slips containing anthropometric data to avoid wrong identification.

Henry along with a few Indian police officers, viz. Khan Bahadur Azizul Huq and Rai Bahadur Hem Chandra Bose worked on classification which remains the basic system even to-day. It was Khan Bahadur Azizul Huq who evolved a mathematical formula to supplement Henry's idea of sorting slips in 1024 pigeon holes, based on fingerprint patterns. Rai Bahadur Hem Chandra Bose made further contribution to the fingerprint science by evolving an extended system of sub- classification, a telegraphic code for finger impression and a system of single-digit classification.

Edward Richard Henry approached the Government to seek approval for replacing the anthropometric data by fingerprints for the identification of habitual criminals. Government readily agreed, and the first Fingerprint bureau in the world was officially declared open at Calcutta in July 1897. Thus, the personnel identification solely on the basis of fingerprints commenced in India.

The first Central Fingerprint Bureau (CFPB) in India was established in 1905 at Shimla which was abolished in 1922 and restarted from 1955 in Delhi under the administrative control of Intelligence Bureau (IB). The major role envisaged for CFPB was to coordinate the activities of State FPBs in tracing/locating inter-state criminals. It is now under the administrative control of National Crime Records Bureau (NCRB) in Delhi. In late 1970s, the FBI introduced the Automated Fingerprint Identification System (AFIS) that automate the storage and searching of fingerprints. The Indian version of AFIS is called FACTS (Fingerprint Analysis and Criminal Tracking System) which was co-developed by NCRB and CMC Ltd., India. The system uses Image processing and Pattern Recognition technique to capture, encode, store and match fingerprints, including comparison of chance prints. It uses pattern class, core and delta information, minutiae location, direction, neighboring information, ridge counts and distances, density, type, print background/foreground information etc. for matching fingerprints. Apart from the above details, FACTS also stores non-fingerprint information or demographic details like gender, region and conviction details.

Explosives department

When the use of explosives for subversive activities became common, it was found necessary to detect the causes of explosion, either accidental or intentional. The foundation of the Department of Explosives was laid when the first chief inspector of explosives was appointed in the year 1898, with his headquarters at Nagpur. Their expertise came handy in police investigations in crimes related to explosions and for evolving various provisions under the Explosives & Petroleum Act.

Government Examiner of Questioned Documents

The greatest hand writing expert of his day, Albert S. Osborn (1858-1936) developed the fundamental principles of questioned document examination and so is credited with the acceptance of the technique by the courts. The British Government of Bengal first created the post of Government Handwriting Expert of Bengal in 1904 to which Mr. C.R. Hardless was appointed. In a couple of years, it was shifted to Shimla in 1906 and placed under the control of the Director, CID. After Hardless, Mr. F. Brewester was designated as the Government Examiner of Questioned Documents (GEQD). Though it was mainly confined to the identification of writings on secret documents in the beginning, later it was open to criminal as well as civil court cases. During the World War II, the organization took up the additional work of secret censorship, including the detection of invisible writings and training of military personnel in this field of science.

Department of Serology

When the science of examining human blood developed in India, it became possible to examine blood and seminal stains in criminal investigations. Realizing the importance of Forensic Serology, an institute named as Serology Department was established in Calcutta in 1910. The head of this institute was designated as Imperial Serologist to the Government of India.

Dr. Hankin helped in establishing this department. Though the scientific techniques for serological examination were at the infancy stage, this institute provided valuable scientific support by analyzing biological materials for crime investigations. After independence, the department was renamed as Office of the Serologist and Chemical Examiner to the Government of India.

Footprint section in CID

In 1915, a Footprint Section was established under the CID, Government of Bengal which helped the police authorities to identify criminals through the examination of footprints collected from the scene of crime.

Note forgery section in CID

In 1917, a Note Forgery Section was set up under the CID, Government of Bengal, to undertake the examination of forged currency notes. Similarly, Government Mint and Security Printing Departments at Nasik also established their own laboratories for detecting cases of counterfeit and forged currency notes.

Ballistics Laboratory

In 1930, an Arms Expert was appointed and a small ballistic laboratory was set up under the Calcutta Police to deal with the examination of firearms. As the menace of firearms grew, other State CIDs also established small ballistics laboratories to help them in the criminal investigation. During 1936, a Scientific Section was set up under the CID in Bengal and facilities were created for examination of bullets, cartridge cases, firearms, etc., used in committing crime.

Forensic Science Laboratories

The first state forensic science laboratory in India was established in the year 1952 at Calcutta. This laboratory became fully operational in the year 1953. The Medico-legal Section of the Chemical Examiner's Laboratory was also transferred to this laboratory. During the year 1955, a small unit of Physics was established in the West Bengal State Forensic Science Laboratory to deal with various physical examinations of exhibits encountered in crime investigation. In 1957, the Physics unit developed into a full-fledged Physics Section. In the same year, the Footprint and the Note Forgery Sections of Criminal Investigation Department were transferred to this laboratory and the General Chemistry Section of the Chemical Examiner's Laboratory was also transferred to this laboratory. Thus the first multidisciplinary forensic science laboratory came into existence in the country.

Central Forensic Science Laboratory

The first Central Forensic Science Laboratory was established at Calcutta during 1957. The lab was organized into four basic disciplines viz. Forensic Physics, Forensic Chemistry, Forensic Biology and Forensic Ballistics. In 1965 the second central forensic science laboratory was established at Hyderabad with analytical facilities in the disciplines of Forensic Physics, Forensic Chemistry and Forensic Biology. Over the years, many full-fledged forensic science laboratories were established in various states. For application of nuclear methods of analysis to criminal investigation, the Neutron Activation Analysis Unit of CFSL, Calcutta was set up in 1970 at the Bhabha Atomic Research Centre, Trombay.

1.2 . FORENSIC SCIENCE INSTITUTIONS AT STATE AND REGIONAL LEVEL – ANDHRA PRADESH MODEL

AP Forensic Science Laboratory

The Government of Andhra Pradesh established a full-fledged Forensic Science Laboratory in the year 1974. The Laboratory is headed by a Director who reports to the Director General of Police, Andhra Pradesh. Four Joint Directors who are in-charge of biological, chemical, physical and general divisions support the Director. Under each division there are different sections and in all there are 12 sections, each headed by an Assistant Director with supporting scientific staff in the cadre of Scientific Officers, Scientific Assistants, Lab Assistants, Lab Technicians and Lab Attendants. The 12 sections and their functions in FSL are:

- Ballistics: Examination of Firearms, parts of firearms, cartridges, cartridge cases, bullets, pellets & wads etc.
- Biology: Hair, fibres, diatoms, plant material, Skull – photo superimposition.
- Chemistry: Explosives, its remnants, residues, components, arson and fire residues, suspected petrol, diesel and other motor oils, acid burn cases etc.
- Computer Forensics: Software, hardware, computer peripherals & products, computer data, text images etc.
- DNA Profiling: Liquid blood, blood stains & swabs, semen, seminal stains & swabs, tissues, bones, hair, teeth, saliva, skeletal remains etc.
- Documents: Handwriting, signatures, initials, numerals etc., erasures, obliterations, alterations, overwriting, secret writings etc., printed matter and photocopies, ink and paper, stamp impressions etc.
- Forensic Engineering: Video authentication, speaker identification, road / train / vehicular accident material etc.
- Narcotics: Suspected powders, liquids, plant products etc., adulterated toddy, liquor etc.
- Physics: Glass, paint, foot prints, shoe prints, tyre impressions, tool marks, counterfeit currency, erased numbers, spurious articles etc.
- Polygraph: To ascertain whether the statements given by suspects are true or not.
- Serology: Blood, semen, saliva, body fluids etc.
- Toxicology: Viscera and body fluids, suspected poisonous substances in plant materials, food syringes, needles, tablets, powders etc., bones, ash, vomit and exhumed remnants etc.

There are eight Regional Forensic Science Laboratories functioning at Visakhapatnam, Vijayawada, Guntur, Tirupati, Kurnool, Warangal, Kamareddy and Karimnagar. The regional laboratories, headed by Assistant Directors with necessary supporting scientific and ministerial staff, under take examination of physical evidence pertaining to toxicology, serology, chemistry and biology sections. These laboratories work under the administrative control of Director, APFSL.

Clues Teams: The Mobile investigation units known as CLUES teams were established in all Commissionerates and District Head Quarters for processing the crime scene evidence and reconstruction of crime scene and for providing assistance to the investigating officers at the crime scene. The Scientific Officer or Scientific Assistant will be in-charge of these teams. Lab Technician / Photographer borne on the strength of FSL and Fingerprint expert borne on the strength of the Fingerprint Bureau will assist him. These three members together constitute the CLUES team, which visits the scenes of crime whenever their services are requisitioned. The CLUES teams are under administration control of Director FSL, but their operational and functional control lies with concerned SP/CP.

The duties and responsibilities of Clues team:

- Video recording, photograph & sketch of the crime scenes, along with the surroundings.
- Systematic search for physical evidence.
- Collection of physical evidence such as blood, dust, fingerprints, fibres, footprints, hair, stains, marks and other microscopic evidence.
- To extend all possible assistance and guidance to the investigating officers. In collection of physical evidence such as casts of footprints, shoe prints and other track marks; collection of tool marks on metals, wood, plastics and other medias, collection of controls and standards for all classes of physical evidence.
- Proper preservation and packing of physical evidence and handing over to the I.O for forwarding to the FSL or other authorities concerned.

Medico-legal services

The Professors of Forensic Medicine working in nine Medical Colleges listed here are responsible for providing Medico-legal services to the investigating officers in the respective districts indicated against each.

Sl. No.	Professor of Forensic Medicine	Jurisdiction
1	Osmania Medical College, Hyderabad.	Mahaboobnagar, Nalgonda & Hyderabad City.
2	Gandhi Medical College, Hyderabad.	Ranga Reddy, Nizamabad, Medak & Secunderabad City.
3	Kakatiya Medical College, Warangal.	Warangal, Karimnagar & Adilabad.
4	Guntur Medical College, Guntur.	Guntur & Prakasam.
5	Siddartha Medical College, Vijayawada.	Khammam & Krishna.

6	Ranga Raya Medical College, Kakinada.	West Godavari & East Godavari.
7	Andhra Medical College, Visakhapatnam.	Visakhapatnam, Vizianagaram & Srikakulam.
8	Kurnool Medical College, Kurnool.	Kurnool, Cuddapah & Ananthapur.
9	S.V. Medical College, Tirupathi.	Chittoor & Nellore.

The services rendered by a medico-legal expert extend to both the living and the dead individuals. Clinical Forensic Medicine deals with the medico-legal examination of the livings pertaining to wounds, sexual offences, age determination, poisoning whereas the Forensic Pathology deals with that of the dead like autopsies, examination of mutilated/fragmentary and skeletal remains, exhumation etc.

Fingerprint Bureau

The Director, Fingerprints Bureau and his supporting staff at the Head quarters and at Finger Print Sections at district level are responsible for lifting, collecting and matching the finger prints in all criminal cases.

Explosives / Bomb Disposal Experts

In all matters relating to explosive substances the following agencies have to be contacted by the Investigating officers in handling, defusion and disposal of explosive substances.

A) Deputy Chief Controller of Explosives, Government of India, Kendriya Sadan, Sultan Bazar, Hyderabad – 500 195.

B) Sub-Area Commander, Military Bomb Explosion Squad, AOC Center, Secunderabad: He should be contacted in dealing with all cases involving military explosives.

C) Bomb Disposal Squad, C/o Addl. Director General of Police, CID., DGP Office Complex, Saifabad, Hyderabad 500 004: This squad should be contacted in all matters relating to defusion of explosives, collection of remnants from the defused, seized or recovered live explosives and explosion residues.

Institute Of Preventive Medicine

Director, Institute of Preventive Medicine, Narayanguda, Hyderabad –500 029; He should be consulted in all matters relating to investigation of cases arising due to epidemic diseases, dog bites, water borne diseases etc.

Chemical Examiner – Prohibition & Excise

Government Chemical Examiner, Prohibition and Excise Department, Regional Prohibition Excise Lab, Narayanguda, Hyderabad – 500 029 and seven other regional

labs situated at Warangal, Nizamabad, Kurnool, Chittoor, Guntur, Kakinada and Visakhapatnam, should be consulted in all the cases of suspected adulterated Toddy, illicit distilled liquor, or any spurious liquor, nonduty paid liquor, any Indian liquor sold unauthorized. However, if death occurs due to the consumption of spurious liquor / Toddy, the remnants of consumed Liquor/Toddy should be sent to A.P. Forensic Science Laboratory along with viscera. Similarly all substances recovered under NDPS Act should be sent to A.P. Forensic Science Laboratory, Hyderabad.

Government Food Laboratories

Director, Government Food Laboratories, Nacharam, Hyderabad–500076, should be consulted in all cases relating to adulterated food items such as milk, milk products; food items sold in hotels, restaurants, fast food shops, sweet shops etc.; edible oils, pulses and grains, honey etc.

Drug Control Laboratories

Inspector General, Drugs & Copy right, Drugs Control Administration, Vengalarao Nagar, Hyderabad-500 038 or any of their regional units have to be consulted in cases relating to manufacturing and sale of spurious / substandard quality drugs and other cases relating to violations under Drugs Price Control Order 1995 and Drugs and Magic Remedies (Objectionable Advertisements) Act-1954.

Central & State Forensic Science Institutions

Currently several Central Forensic Institutions are functioning under the Directorate of Forensic Services, Ministry of Home Affairs at Hyderabad, Chandigarh and Kolkata.

There are six laboratories that come under the Directorate:

- CFSL, Calcutta (Forensic Biological Sciences)
- CFSL, Hyderabad (Forensic Chemical Sciences)
- CFSL, Chandigarh (Forensic Physical Sciences)
- GEQD, Kolkata (Forensic Documents)
- GEQD, Hyderabad (Computer Forensics & Documents)
- GEQD, Shimla (Forensic Documents)

Similarly all States have established State level Forensic Science Labs, Fingerprints Bureaus and Medico-legal Institutions etc. to cater the criminal investigation dispute resolution requirements.

1.3 PHYSICAL EVIDENCE AND ITS ROLE IN CRIME INVESTIGATION

It is an established fact that the criminals while committing crimes either due to carelessness or due to anxiety, or due to contact with other objects leave traces at the scenes and these are the basis for scientifically exploiting their culpability. This physical evidence when located, collected, preserved and forwarded for scientific evaluation and report is bound to have enormous potential in linking the criminal to the crime scene,

victim or any other circumstances leading to the crime. Moreover evidence collected and based on scientific evolution and report is unbiased, universally acceptable and also stands the test of time.

Evidence in general is anything that tends to prove or disprove a point under investigation or consideration. *Physical Evidence* is evidence having a physical or material quality – a tangible article, no mater whether microscopic or macroscopic. It encompasses any and all objects, living or inanimate, solid, liquid or gas. Physical evidence can alternatively be called as material evidence, objective evidence, circumstantial evidence or indirect evidence in different contexts. Physical Evidence includes all naturally occurring substances as well as machine/men made objects in the Universe.

4.1 Purpose of Physical Evidence in Crime Investigation

The goal of physical evidence examination is to provide useful information for criminal investigators in solving crimes and for courts of law, during the adjudication of these cases. The following leads can be obtained from the examination of physical evidence in the process of investigation.

1. Information on the corpus delicti: The corpus delicti (literally means the body of the crime) refers to those essential facts which show that a crime has taken place. E.g. Tool marks, broken doors or windows, ransacked rooms and missing valuables would be important in establishing burglary has taken place.
2. Information on the modus operandi (MO): Many criminals have a particular modus operandi or (MO), which is their characteristic way of committing a crime. Analysis of physical evidence for the establishing of an MO is the basis of linking cases in the investigation of a serial killer or rapist.
3. Linking a suspect with a victim: This linkage is one of the most common and important aspects that physical evidence can help to establish. Blood, hairs, clothing fibers, cosmetics and other items from the victim may be transferred to a perpetrator. Items found in a suspect's possession can sometimes be linked to a victim. For example, through the comparison of bullets with a weapon seized from the suspect, the suspect can be linked with the crime. It is also possible that evidence is transferred from a perpetrator to a victim; in rape, murder and assault cases.
4. Linking a person to a crime scene: This type of link is also one of the most vital in a crime scene investigation. Numerous types of evidence may be deposited by the person committing a crime, including fingerprints, foot prints, blood, hair, fibers, and soil. In addition, the type of weapons or objects used may also leave evidence like bullets and cartridge cases or tool marks. Depending on the type of crime, various kinds of evidence from the scene may be carried away intentionally such as a stolen property or unintentionally such as a transfer of trace evidence like carpet fibers or hairs on the criminal's shoes or clothing. These materials are extremely useful in linking an individual to a particular crime scene.
5. Proving or disproving a witness testimony: Physical evidence analysis can often indicate conclusively whether a person's version of a set of events is credible, or whether an alibi put forth is convincing or not.
6. Identification of a suspect: The best evidence for identifying a suspect is his or her palm prints and evidence such as blood, semen, saliva, skin tissues etc. collected for DNA Finger Printing examination. A fingerprint found at a scene, and later identified as belonging to a particular person, results in an unequivocal identification of that

person as having been at the scene.

7. Providing investigative leads: Physical evidence analysis can assist the investigator in pursuing a productive path, by providing clues from the characteristics of the physical evidence.
8. Crime Scene Reconstruction: Transient evidence such as odour, temperature (of car engine, fire debris etc), imprints, marks/stains; pattern evidence like blood stain patterns, skid mark patterns, gunshot residue patterns, projectile trajectory patterns, glass fracture patterns etc., and conditional evidence such as light, smoke, fire, water, piled up news papers etc., will play a key role in reconstruction of the events surrounding the crime scene and the nature of offence.

4.2 Sources of Physical Evidence

The primary source of physical evidence is generally the crime scene but it is by no means the only source. Many crimes occur over multiple scenes and many criminals carry physical evidence away from the actual scene in addition to leaving evidence behind. The victim, suspect and sometimes the witnesses are major sources of physical evidence. The methodology of search depends on the case and the scene. The purpose of the search is to look for clues and for evidence of what happened during the crime. It is not a random groping in dark but rather a directed search for objects and materials. Recognizing, recording, collecting, marking, packaging and preserving evidence discovered while searching a crime scene is the basic essential duty of the investigating officer. In cases where the evidence is of a common nature, i.e., evidence, which is not hidden and is easily collectable, without expert's assistance, the Investigating Officer should invariably collect all possible forms of physical evidence. For other kinds of evidence the investigator should take the assistance of CLUES Team or medico-legal experts. Some types of physical evidence, which are hidden, latent or fragile, require scientific procedures for location as well as collection and packing.

Scene of Crime

The scene of crime cannot be limited to one place only. For example in a scene of crime such as burglary it may be divided into the following:

1. Line of approach
2. Point of entry
3. Actual scene
4. Point of exit and
5. Line of retreat

1.4 CRIME SCENE PROCESSING

The importance of the crime scene, its protection and preservation cannot be over-emphasized. Successful investigation of a crime largely depends upon how well various clues, leads, and evidence available at the scene of crime are protected, located, recorded, processed, evaluated and interpreted. The observations and findings in an undisturbed crime scene are vital to the success of the investigation. An improperly secured and unprotected crime scene may lead to loss, destruction or contamination of various forms of evidence, especially physical evidence. Moreover evidence once overlooked cannot be retrieved at a later stage. Therefore the scene of crime should be properly secured and protected as a first step by the investigator and all available evidence preserved in an appropriate manner thereafter.

5.1 Protection of Crime Scene

The first action of the investigating officer who first reaches the scene should be to secure the crime scene from unauthorized persons by setting up barricades/tapes and cordoning off the area required. The best physical evidence is normally found at the place where use of force against persons or property has taken place. Sometimes valuable pieces of evidence may be discarded or dropped or it may fall off accidentally or inadvertently at some distance from the scene of crime. Such spots also need proper protection. All such critical areas should be secured from intruders and stray animals or neighbours, friends, sympathizers, curious onlookers, newspaper reporters, press photographers and others who are not officially connected. The whole area should be cleared of all unauthorized persons in quickest possible time. The Press and other Media should be requested to keep beyond the barricaded/secured area. The following steps should be taken for protection of the scene of the crime:

1. The first priority is to provide medical aid to the injured persons to save their lives.
2. Cordon off the scene and surroundings, access and exit points effectively.
3. Identify and persuade to retain the person who first informed the Police. Otherwise, note his address, telephone number etc.
4. Persons who are likely to provide information, investigative leads and other pertinent details should be segregated and examined for collecting all possible information, Eye-witnesses should be requested and allowed to stay at earmarked place for examination.
5. Physical evidence should be protected from pet animals like dogs, cats, rabbits, etc., and also rats, mice and birds, as also from adverse environmental influences such as wind, rain, sunlight, dust, smoke, moisture, etc.
6. No physical evidence should be disturbed from its original position without properly recording it. Jewelry, keys, currency notes and other valuable items with evidentiary value, vulnerable to theft from the scene, should be removed and preserved after a seizure list is drafted.
7. During the preliminary inspection of the crime scene care should be taken to ensure that nothing is inadvertently dropped such as cigarette butts, match sticks, empty packs of cigarettes, match boxes, ash, etc. and nothing is touched that may cause interference with the fingerprints, footprints, etc., and nothing is added such as hair etc.
8. All physical evidence / traces should be lifted only after recording and thoroughly searching the crime scene. Where traffic is to be restored or place required for use, the examination of scene and other work should be completed as expeditiously as possible but with thoroughness.
9. It should be borne in mind that evidence may not always be visible to eye. Even if visible, it may escape a non-observant eye or may not appear relevant. It is therefore necessary that the scene or places be subjected to close scrutiny both by experts (Clues Team) and the Investigating staff.

5.2 Preservation of Evidence

Simultaneous steps should be taken to preserve all valuable items or objects of evidentiary value at the scene. This is vital, as certain types of evidence is likely to get evaporated, decomposed, putrefied, degenerated or may undergo other chemical or

biological changes with time and other environmental factors. Suitable containers like polythene or glass bottles, polythene bags, paper envelopes, aluminium foils etc.

5.3 Recording of the Crime Scene

The police have a limited time and opportunity to make an in-depth study of the crime scene in an undisturbed state. No time should therefore be lost to record as accurately as possible the conditions existing when investigating officer arrives at the scene. Such a record will help the on- going investigations, reconstruction of the scene of crime and also presentation in the Court. The judiciary and defence counsel need convincing evidence to substantiate the conditions and circumstances reported prevailing at the time of the crime. It is therefore necessary to make a visual presentation that shows the various evidentiary items, witnesses and their interrelationship with the scene of crime. The methods of crime scene recording are Photography, Sketch, Observation notes, Videography and Audio tape recording.

I. Photography

Photography is a useful method to make a permanent record of the crime scene and facilitates the reconstruction of the crime scene and description of the method by which the crime was committed. Photography is the best method of recording, serving several purposes including:

- A method of recording and storing information more accurately and for a much longer period than the human mind.
- A method by which evidence of transient and perishable nature can be recorded.
- A method by which certain details of evidence not normally perceivable by the human eye can be arrived at.
- A method by which vital and crucial facts can be illustrated two dimensionally.

Digital photographic cameras currently being used by CLUES teams facilitate quick reviews and recall of photographs on the screen and also permit transfer of data to FSL Headquarters, or any other location through computer and modem. Hence the IOs should prepare to capture the crime scene photo through Digital cameras.

As per section 9 of the IE Act, photographic evidence is admissible to explain or introduce a fact. To ensure that the facts recorded by the photographic process represent a truthful picture, they should be (a) relevant and material to the case (b) faithful and truthful reproduction of facts, events, evidence etc. (c) free from distortion with correct tones, perspectives, positions and interrelationships and (d) should not be of a nature that arouses undue prejudice or sympathy.

(a) How photographs should be taken:

The scene of crime is available for a limited period only, with no scope for trial and error. Care is essential to obtain as much information from it as possible, as early as possible both by still photography and videography.

1. The scene of crime should be kept undisturbed before taking the photographs.
2. The working condition of camera, lens, flash, batteries, film, etc. should be checked before attempting any photograph. The film or the other recording medium such as tape, floppy, CD-R etc. used should be appropriate for the lighting conditions and

capabilities of the camera.

3. Before commencing the work, the whole area should be inspected and all the shots required should be carefully planned.
4. While planning the number of shots, ensure that enough overlapping shots are included to sequentialise the scene.
5. Initially sufficient number of shots should be taken to give an overall perspective of the place of occurrence, approach to the place, entry, access and exit points.
6. While photographing evidentiary items, indoors or outdoors, enough overlapping shots and close-up shots should be taken to bring out interrelationships and to capture minute details. It is better to have three views taken viz.; overall view, mid-range view, and close- up view of all important items of evidence.
7. All photographs should be taken at eye level. In some unusual cases aerial views or below normal views may be taken depending on the crime scene and surroundings.
8. The chance fingerprints, footprints, etc. left at the scene of crime, should always be exposed from a close distance.
9. A scale or foot rule should be placed beside evidentiary items such as footprints, knife, injuries, cut marks, etc. to indicate the actual size in the enlarged photograph.
10. It is worthwhile to include separate numbered cards or plates for each evidentiary item so as to ensure proper identification at a later stage.
11. After unloading the film and any other recording medium, it should be properly labeled, with details of the place, event, police station, date, case number, etc.

The observation notes should cover the following points:

- Name of the photographer and address
- Date and time each photograph was taken
- Distance maintained between the lens and the object and direction
- Technical information such as Type of Camera, Focal length of lens, Speed of the lens, Effective aperture, Shutter speed, Film speed, Type of Flash. Similar information should also be maintained to digital still or video cameras.
- Special techniques such as oblique light, flood lamps, flashlight, UV light, Polilight, Filters etc., if used, should be noted against each shot.
- Light and weather conditions in cases of outdoor shots. Searching the Crime Scene for

II. Videography and Audio Tape Recording

Like photography, videography and audio tape recording are useful in making a record of a crime scene, which help in scene reconstruction at later stage. In certain crimes like arson, videography provides an overall view of the scene and allows investigators who could not be present at the scene to visualize the important pieces of evidence and their relationship to one another. Videotaping should be used to supplement the information that is collected from other recording procedures viz., photography, digital photography, sketching and observation notes. A videotape review conducted with all the connected personnel will help reconstruction of the crime scene. It is advantageous because of its freeze frame capability, which allows Investigating Officers to replay, study and discuss particular scenes as often as necessary for reconstruction and continue the investigation. It is also possible to locate certain minute pieces of evidence recorded immediately after the incident but overlooked for collection. The process of video documentation is

similar to still photography. In a burglary case for example the Videography should start at the actual/suspected point of entry, cover the crime scene, point of exit and line of retreat. All- important spots can be focused through a zoom lens and more time can be allotted to cover from all angles. Further the voice recording capability can be used to describe what is seen while recording simultaneously. This capability can be also used in presenting to the Court to serve as a convincing proof. All the precautions suggested earlier for photography should also be followed for these recordings.

III. Sketching the Crime Scene

After the scene is photographed, it should be sketched, to provide measurements indicating the relative distance and position of the various items of evidence and their interrelationships. The sketch is the first visual record of the condition of the crime scene. It portrays the crime scene and items within that scene that are of interest to the investigation. Sketches properly prepared are useful during the interrogation of witnesses, in making notes in the case diaries and in presenting information to the court. The sketch complements the photographs and notes made while observing the crime scene. The ultimate purpose of the crime scene sketch drawn as per set scale and plan, which is also known as crime scene planning, is to represent the facts of the crime with such clarity and precision that the crime itself may be reconstructed from the details. Courts rely to a great extent on sketch of the scene prepared.

All sketches should cover the following aspects:

1. In the case of indoor scenes, the size of the window(s) and room(s) and in the case of outdoors, area dimensions with reference to some fixed objects like trees, electric or telephone poles, lamp posts or other landmarks should be indicated.
2. The approach to the crime scene such as roadways, streets, by lanes, pathways, etc. should also be drawn to facilitate reconstruction.
3. The orientation of the scene with reference to magnetic north.
4. The apparently visible items should be indicated by accurate measurement from at least two fixed points.
5. The position of eyewitnesses and accused persons and places indicating all stains, footprints, tyre or drag marks and other objects of victim or accused.

The following information must invariably be mentioned on the sketch.

- The investigator's full name, rank, address.
- Crime number, section of law, police station, and district
- Address of the crime scene, its position in a building, landmarks and compass direction
- The visible items of physical evidence and critical features of the crime scene. A legend to the symbols may be used to identify objects or points.
- The rough sketch once drawn should not be altered. A smooth or fair sketch should be prepared on the basis of the rough sketch. The smooth sketch also known as crime scene plan drawing is prepared as per a convenient scale and plan from the details of rough sketch. Color drawing will be helpful to distinguish various objects or the features of an object.

IV. Crime Scene Observation Notes

1. Method of Recording: The notes should start with the time of receipt of first information. The notes can be recorded as and when the observations are made and need not be in sequence.
2. Date, time and location: The time and date of arrival at crime scene and the details of its location, environmental conditions (smoke, rain, dusk, dawn, etc.), the names of persons present at the scene on arrival, should be recorded.
3. Description of the victim and clothing: The name, age, height, weight, complexion, colour of hair and eyes and, if possible, the date of birth of the victim should be noted. Outer garments should be described in terms of type of garment and colour.
4. Wounds on the victim: The exact location of a wound or injury, its type, size and in the case of a bruise, its colour.
5. General Description: Damage to items and any apparent disturbance of the normal arrangement of furniture or other objects and also the presence of objects that seem unusual in the context of the scene.
6. Recognition of each significant item of evidence: The description of each significant piece of evidence found or identified with special techniques with complete details, such as the time when it was found, the exact location, who found it, how it was marked, sealed and packed.
7. Missing items: The purpose of this entry is to note items that should have been normally associated with the crime being investigated, but which are absent at the crime scene or on the victim or deceased. For example, an item of clothing missing from the victimÊs body that could not be located at the scene of crime and which, if found later from the suspect or elsewhere, should be useful in linking evidence and suspect or vice-versa.
8. Other important information: The condition of doors, windows, locks, wrist watches, clocks, water taps, electric lights, and other household gadgets as well should also be recorded carefully.
9. Miscellaneous: Any other details not included in photographs and sketches such as condition of surroundings, minute details on various items of evidence such as serial number, model, make of firearm, etc., should be recorded. The investigating officer can reorganize all these notes for preparing his case diary and charge sheet.

5.4 Searching the Crime Scene for Physical Evidence

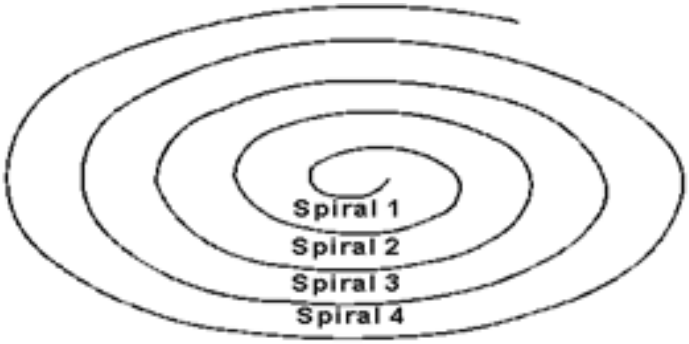
1. The primary purpose of inspecting the scene of crime is to search for any evidence left behind by the criminal while committing the crime. Such evidence will be invariably present in all scenes of crime and is based on the Locard's principle of exchange. Such exchanges may be large or small, visible or invisible, detectable readily or difficult to detect, but such exchanges does occur. It is therefore the primary responsibility of Investigating Officers to search, identify and collect such evidence independently or with the assistance of CLUES Team.
2. The crime scene is highly dynamic and is constantly undergoing change. It is also fragile, in the sense that the evidentiary value of the items it contains can be easily lost or downgraded. Usually there is only one opportunity to search the scene properly. Hence making a good overall survey of the scene is quite essential.
3. A competent search of a crime scene requires a thorough understanding of crime, its nature, extent of damage, people aggrieved, property lost or damaged and the manner in which the offence was committed. All items should be searched with equal care

and concentration. The search should be carried out carefully, avoiding unnecessary disturbance of the scene.

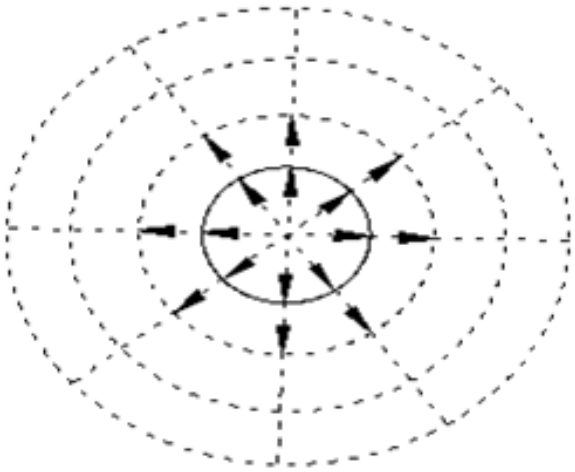
4. The scene of crime can be classified as Indoor scene and outdoor scene of crime. In an indoor crime scene one should not ignore the space concealed behind the door leaf, the portion of the floor covered by carpets, or mattresses, behind and under the Trunks, suitcases and boxes and other items of furniture like almirahs, sofa sets, tables, chairs etc. Cracks in the floor, curtains, new paint, or plaster, light fixtures, switch boards and fuse boxes, behind the wall hangings, articles with possible false containers, must not escape the notice of the Investigating Officer.

5.5 Methods of searching outdoor scenes of crime

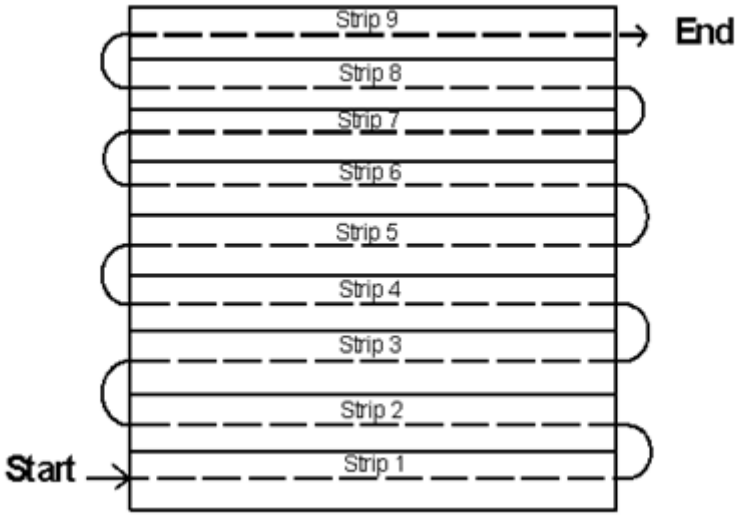
a. Spiral method: The search is conducted following a spiral pattern working from outside to inside towards the centre or focal point (towards the body, safe or any other key feature) or vice versa, either clockwise or anti clockwise. It is an effective search pattern for single person search, with a very high probability of locating minute evidence like fingerprints, footprints, etc. Also, there is not much likelihood of the evidence being destroyed by the investigator's movements.



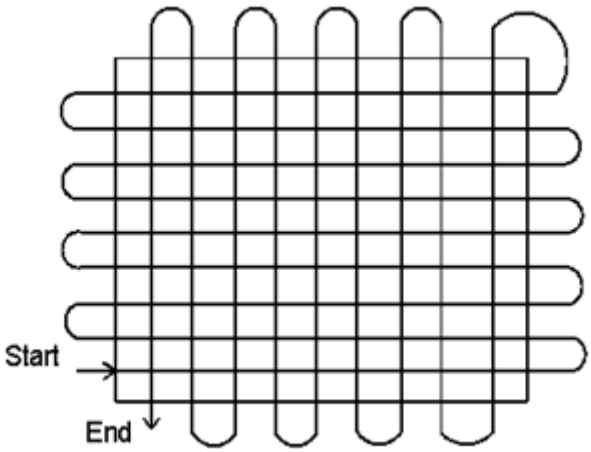
b. Radial method: In this method, the investigator works outward from the centre along the radial, and moves in circles of increasing circumference repeatedly. This method provides a double check on the searched area and is one of the best methods available for both indoor and outdoor searches. This method is preferred if more than one officer is conducting the search.



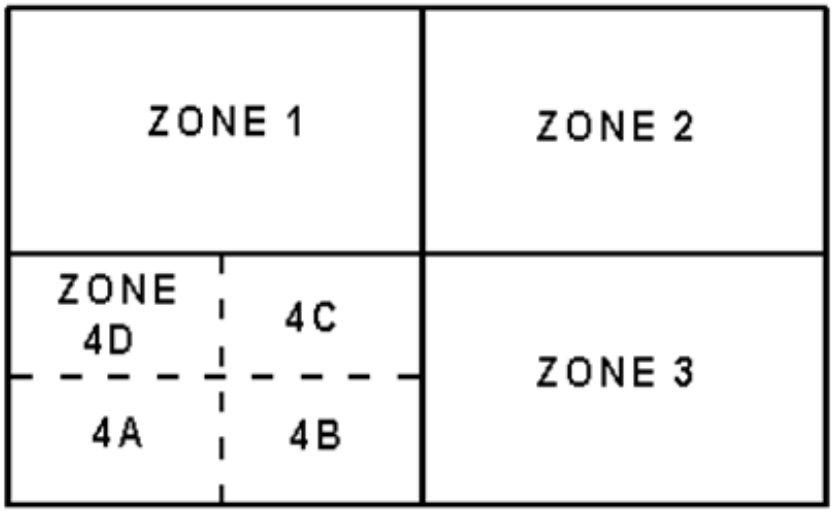
c. ***Strip method:*** This is a sector search, useful for both indoors and outdoors, in which the crime scene is divided into segments or strips. The method works well if the area to be searched is square or rectangular in shape with clearly marked boundaries. The search may be conducted by one or more officers depending on the size of the area and availability of officers.



d. ***Grid method:*** Grid method is a slight modification of the strip method. This method is useful for small areas especially indoors. The area is divided into grids. In this method a single person can search the entire area by moving at right angles, and covering all the squares of the grid.



e. Zone method: If the crime scene is large and enough personnel are not available, it is advisable to divide or sub divide, the area into smaller zones and sub zones and use this method of search. The method is particularly useful for searching in details the enclosed areas where items such as almirahs, safes, etc. have to be carefully inspected, and for cars or carriages which may contain minute trace evidence, necessitating a thorough search of all nooks and corners.



5.6 Classification of physical evidence at crime scenes

Virtually any type of material can become physical evidence. It can occur in the form of patterns or be in the form of a particular physical object. Because of the diversity of physical evidence, it is virtually impossible to identify a classification scheme which will be applicable in all cases. In general, physical evidence may be found at a crime scene in the following four forms: transient, pattern, conditional and transfer.

1. ***Transient Evidence:*** it is a type of physical evidence that is temporary in nature and can easily be changed or lost. The most commonly encountered transient evidence includes odour, temperature, imprints and indentations and markings. It should be recorded and documented by notes and photography.
2. ***Pattern Evidence:*** it is generally produced by forcible, direct contact between persons and objects or an object with another object. Most of these physical patterns are in the forms of imprints, indentations, striations, markings, fractures or depositions. It is extremely valuable in the reconstruction of events. E.g. Blood spatter patterns, glass fracture patterns, fire burn patterns, projectile trajectory patterns etc.
3. ***Conditional Evidence:*** it is produced by a certain event or action. If not documented carefully, this evidence may be changed or lost. Conditional evidence is extremely important for crime scene reconstruction and to determine the set of circumstances of a particular event. Eg. Lighting conditions, density or direction of smoke, spread and temperature of flames, location of weapon or objects related to crime scene, condition of body etc.
4. ***Transfer Evidence:*** it is a classical type of physical evidence which is produces by physical contact between persons or objects. It can be classified according to many different criteria. The commonly used classification schemes for transfer evidence are:
   - Classification by type of crime: There is a correlation between the type of crime and the type of evidence which serves as a reminder while searching for transfer evidence. However different physical evidence types are not restricted to define crime classifications. For example, bloodstains which are frequently found in assault and homicide cases may be just as important as evidence at a burglary scene.
   - Classification by general nature of evidence: Evidence can be classified as

physical (firearm, tool, cartridge case etc.), chemical (narcotics, gunshot residue, glass, paint etc.) or biological (blood, hair, teeth, tissue etc.). It can also be classified as animal, vegetable and mineral in nature.

- Classification by physical state of evidence: According to its physical state it is classified as solid (clothing, tools, glass etc.), liquid (blood, accelerants etc.) or gas.

Control Samples

The examination of evidence whether it is soil, blood, glass, paint, hair, fiber, etc., often requires comparison with a known standard or a control sample. Therefore, while collecting physical evidence, the investigator must not forget to collect the control sample. Control sample means specimens of material e.g. vegetation or soil from the scene, sample of blood, hair or fingerprint from the victim which are collected for comparison with any questioned material from the crime scene. Control sample is an essential requirement of all examination in the laboratory. For the purpose of comparison, samples must be taken from the correct places according to the circumstances of each case. It should be remembered that like can be compared with like.

1.5 PRINCIPLES AND LAWS GOVERNING FORENSIC SCIENCE

6.1 Locard's exchange principle

This was the first and foremost concept that led to the systematic development of forensic science. Edmond Locard, a French scientist postulated the exchange principle in 1928 which states that every contact leaves a trace. Whenever two objects come into contact with one another, there is always a transfer of material across the contact boundaries. Such transference may be large or small, visible or invisible, readily detectable or not. Nevertheless transference does occur. It is the responsibility of the investigating officer to search, locate and collect it.

6.2 Principle of evidence recovery

No harm is done to the evidence. Nothing should be added, lost, damaged or obliterated in the recovery process. Particular attention should be paid to avoiding contamination. Great care should be taken when there is a risk of losing or damaging evidence. Exhibit items are safely and securely packaged and transported to the laboratory.

6.3 Law of individuality

Two objects may be indistinguishable but no two objects are identical. They are unique.

6.4 Law of progressive change

Everything changes with the passage of time.

6.5 Principle of comparison

Only the likes can be compared. Two objects are said to match when there are no unexplained, forensically significant differences between them. If a comparison is conducted as the final and ultimate test, the motto is if in doubt, exclude whereas if the

comparison is conducted as a screening prior to the other tests, the motto is if in doubt, include.

6.6 Principle of analysis

Using the scientific method which includes observation, data collection, develop a hypothesis, testing results and develop a theory. However improper sampling and contamination render the best analysis useless.

6.7 Principle of presentation

The laboratory report should be readily understandable, impartial and neither overstated nor understated. Full disclosure of all facts, assumptions, data, conclusions and interpretations should be made.

1.6 HANDLING OF PHYSICAL EVIDENCE

Evidence collected at the scene of crime can be so varied in type, size, delicacy, and degree of perishability that there can be no set procedure laid down to cover all aspects. However, each article should be collected bearing in mind the following points:

1. Avoid temptation of picking up an article immediately on arrival at the crime scene.
2. Use a pair of rubber gloves while handing every article.
3. Handle articles as little as possible so that no clue is lost or damaged.
4. Prevent careless destruction of any evidence.
5. Maintain integrity of the evidence material, i.e., original character of the evidence.
6. Ensure chain of possession of evidence collected.

While handling evidence only such parts of the articles should be touched as are not likely to have been touched by anyone else previously as noted below:

a. In case of a flat object like a piece of wood or glass sheet only the edges should be handled.
b. In the case of tumbler, bottle or phial only the rim and the bottom should be touched, using a single finger at top and bottom.
c. In the case of dagger or knife, the tips of the handle and the blade should be handled by the tips of the index fingers.
d. Fire arms can be lifted with the tips of the fingers held against the ends of the barrel and the butt.
e. A fired projectile should be lifted only with a rubber tipped forceps.
f. Paper, hairs, fibers, small pieces of glass or any small sized solid object should be lifted with forceps.
g. Dust or other powdered substances should be collected with a brush or, if available, a vacuum cleaner.
h. Explosives and bombs should not be touched or handled unless one is sure that there will be no explosion by simple handling.
i. Blood, semen, liquids, chemicals, vomit and excreta etc., should be collected with the help of a spoon.

1.7 PACKING AND LABELING OF EVIDENCE

The following points should be borne in mind with regard to the packing of exhibits:

i) The exhibits contained in the package are not damaged by knocking against each other and are properly padded with cotton, thermo coal etc.
ii) Each article should be separately packed and labeled so that the individually and identity are maintained.
iii) The packing should be secure and nothing should penetrate or seep through, to contaminate the contents.
iv) As far as possible all packets belonging to a case should be enclosed in a box or outer covering to form a parcel, unless disparity in sizes of various articles makes this impossible. Packets of articles belonging of different cases should not be enclosed in one parcel.
v) The exhibits inside the packing, especially fingerprint articles, do not come in contact with each other or the sides of the package.
vi) The exhibits are not contaminated by being in unclean containers. The exhibits do not spill due to the use of unsuitable lids and stoppers.
vii) The container is strong enough to avoid damage in transit.
viii) The exhibits are packed in a manner that they cannot be damaged when being unpacked.
ix) The labels are not pasted over weapons, tools or clothing's suspected to contain any stains.
x) The topside of the box is always indicated on the top of the box containing the exhibits and marked "Handle with Care".
xi) The exhibits are sent through a special messenger as far as possible. If sent by post the parcel should be properly addressed, labeled, and preferably, insured.
xii) Postal regulations should be kept in mind while dispatching exhibits like firearms and explosives.

8.1 Sealing

All parcels should be carefully sealed by the dispatching officers and packed in such a manner that they cannot be opened without destroying the seals. All knots should be sealed. The impression of the seal should be legible. The seal should be kept in safe custody of the dispatching officer at all times. The seal could be a private or official but should never be an impression of keys, coins, buttons, etc. The facsimile of the seal should always be sent along with the forwarding letter.

Physical Evidence –Packaging and Storage

Type of evidence	Packaging	Transportation/Storage
Clothing (if wet, should be allowed to dried naturally before packaging)	Clean wrapping paper or Paper bags	Cool dry environment
Shoes	Paper bags	Cool dry environment

Cigarette ends	Sterile container, envelope or paper bag	Freeze if wet, Cool dry environment
Condoms	Sterile plastic or glass specimen jar	Do not air-dry the sample. Refrigerate or freeze
Sanitary wear	Polythene bag if wet, paper bag if dry	Freeze if wet, Cool dry environment
Intimate Samples		
Swabs	Air dry prior to packaging in paper and place in envelope	Cool dry environment
Hair	In a paper fold, placed inside a polythene bag or envelope	Cool dry environment
Tissue/ organ/ bone	Placed in a clean container using forceps	Freeze if blood is present, cool dry environment
Semen	Swab or scrape as appropriate into sterile swab tube or eppendorf tube respectively	Freeze
Blood stains	Swab or scrape as appropriate into sterile swab tube or eppendorf tube respectively	Freeze
Blood sample (liquid)	Sealed vial with anticoagulant	Refrigerate or Freeze
Urine sample	Sterile container	Refrigerate or Freeze
Particulate traces		
Glass	Pieces taped to cardboard box, placed inside a polythene bag	Cool dry environment
Paint	Scrapings are placed in a paper fold, and in an envelope	Cool dry environment
Dry particulate debris	In paper fold, placed inside a polythene bag or envelope	Cool dry environment
Wet particulate debris	In a plastic petri dish, placed	Allow to air dry to a constant

	inside a polythene bag	weight, cool dry environment
Fibre tapings	In a paper fold, sealed individually in an envelope or polythene bag	Cool dry environment
Fires/Explosives		
Fire debris samples/ Accelerants/volatile materials	Clean air tight metal can or glass bottle if it is a liquid	Cool dry environment
Explosive materials	Clean dry air tight glass jar or cans if non flammable and metal cans with metal covers for flammable materials	Cool dry environment
Controlled substances		
Drugs	Packed in a paper fold and then placed in an envelope or plastic bag	Cool dry environment
Plants material	Paper bags	Cool dry environment
Drug paraphernalia like syringes, cigarettes, needles etc.	Appropriate containers like plastic weapons tube for syringe/ needle	Cool dry environment
Other items		
Documents (containing latent fingerprints)	Place inside plastic envelope using forceps	Cool dry environment
Weapons/tools	Rigid tubes or tie into cardboard box and place inside polythene bag. Cartridge casings and bullets are placed envelopes individually	Cool dry environment
Tool marks/ impression marks	The silicone cast is stuck to a card and sealed in an envelope	Cool dry environment
Soil	Heavy duty paper bags or glass containers and sealed	Cool dry environment
Footwear casts	Cardboard box within polythene bag	Cool dry environment

1.8 CHAIN OF CUSTODY OF EVIDENCE

The term *chain of custody* means maintaining a record of every article of evidence, from the point of discovery at a crime scene to its collection and transport to the laboratory for examination, and its temporary storage till it is finally submitted to the Court. The *chain of custody* must be established whenever evidence is presented in Court as an exhibit. Otherwise, the evidence may be inadmissible in Court. For this there must be a systematic record of the names of the persons through whom the exhibits were passed to whom they were delivered, their initials, time and date of receipt delivery.

Each person in the chain of custody is responsible for the care, safekeeping and preservation of an item of evidence while it is under his control.

1.9 CHECK LIST OF PHYSICAL EVIDENCE – CRIME WISE

OFFENCE	***TYPES OF PHYSICAL EVIDENCE***
1. Dacoity / Robbery	Weapons used, blood stains, foot prints, tyre marks of the vehicle, finger prints, articles / implements leftover by the offenders.
2. Dacoity (Involving Fire Arms / Explosives)	In addition to the above Firearms, parts of firearms, cartridge cases, bullets, pellets/wads, clothes and other materials affected by firing, close range firing effects such as scorching, blackening, tattooing, entry and exit wounds. Explosives, its remnants such as metallic balls, stones, nails (used as missiles), residues, components, unexploded explosives / bombs etc.
3. Murder	Blood stains, saliva, other body fluids, skin tissues, blood swabs, weapons used, foot prints, finger prints, glass pieces, fragments, tyre marks, tool marks, poisonous substances, drugs, intoxicating substances like alcohol, sedatives, barbiturates etc.
4. Rape and Murder	Liquid blood, blood stains and swabs, semen, seminal stains and swabs, saliva, other body fluids, skin tissues, hair, fibre, nails, clothing of victim and culprit, personal belongings, tyre marks, foot prints, struggle marks, bite marks, bangle pieces etc.
5. House Burglary / Thefts	Finger prints, foot prints, tool marks, tools / implements, articles leftover by the culprits, glass pieces, fragments, paint, tyre marks,
6. Suicides	(a) Hanging: Knot, saliva, other body fluids, semen etc. (b) Drowning: Diatoms, plant material like pollen, leaves, wood, seeds, flowers, fruits etc (c) Burning: Inflammable materials like petrol, diesel, kerosene etc. (d) Poison: Poisonous substances, plant materials, food, syringes, needles, tablets, powders, vomit etc.
7. Arson and Fire Accidents	Inflammable materials such as patrol, diesel, kerosene, arson and fire residues, unknown chemicals etc.

8. White Collar Offences	Suspected hand writings in the form of running matter, signatures, initials, numerals etc., Erasures, obliterations, alterations, overwriting, secret writing etc., Type writing, printed matter and photocopies, inks and paper, stamp impressions, Photostat, fax and carbon copies etc.
9. Narcotic and Psychotropic Offences	Suspected powders, liquids, plant products etc., suspected toddy, liquor, components used for preparation of adulterated toddy, liquor etc.
10. Road Accidents	Tyre marks, skid marks, debris, spilled load of the vehicle, glass pieces, fragments, blood stains, transferred foreign paint, body parts, tissues, cloth fibres etc.
11. Cyber Crimes	Software, hardware, computer peripherals, storage media, communication devices, voice files, image files, computer printouts.

1.10 CHECK LIST OF PHYSICAL EVIDENCE – FSL SECTION WISE

SL. NO.	***SECTION APFSL***	***TYPES OF PHYSICAL EVIDENCE***	***NATURE OF CRIME***
1.	Ballistics	Firearms, parts of firearms, cartridge cases, bullets, pellets / wads, clothes and other materials affected by firing.	Murder, assault, suicide, attempt to murder, dacoity.
2.	Biology	Hair, fibres, diatoms, tobacco products, other plant materials like pollen, leaves, wood, seeds, fruits, flowers etc., and insects such as maggots, files skull, skeletal remains, skin and tissues, photographs.	Rape, murder, suicide, drowning, cheating, suicide, murder.
3.	Chemistry	Petrol, high speed diesel, lubricating oils etc., detergents, cosmetics, cement, explosive, materials, arson & fire residues, acid burning residues, unknown chemicals, remnants of mechanical explosions, chemical explosions.	Explosive cases, accidents, arson, fire, acid burning.
4.	Computer Forensics	Software, Hardware, computer peripherals, storage media, communication devices, voice files, image files, computer printouts.	Hacking, source code alteration, obscene e-mails, data manipulation, virus spreading and child pornography, computer, etc.

5.	DNA	Liquid blood, blood stains & swabs, semen, seminal stains & swabs, tissues, bones, hair, teeth, saliva, skeletal remains.	Rape, murder, disputed paternity, swapping of new born babies.
6.	Documents	Handwritings, erasures, obliterations, alterations, over writings, secret writings etc., type writings, printed matter, inks and paper, stamp impressions, fax, carbon copies, Xerox copies.	Cheating, forgery misappropriation, murder, suicide, frauds, financial scams.
7.	Forensic engineering	Materials recovered in substandard construction of buildings, roads, dams; road, train or air accidents, failures of machines and structures; video authentication; speaker identification.	Fraud, misappropriation, negligence, cheating.
8.	Narcotics	Plants and plant products containing narcotics, and psychotropic substances, adulterated liquor, adulterated toddy.	Cheating, NDPS Act cases, central excise cases.
9.	Physics	Glass pieces and fragments, paint flakes, chips and smears, foot prints, shoe prints, tyre impressions, tool marks, counterfeit currency, erased numbers on vehicles and other valuable gadgets, spurious articles.	Cheating, burglary, rape, accident, murder, hit and run cases.
10.	Polygraph-Lie Detector	Suspects, witnesses or complainants	Burglary, dacoity, theft, arson, rape, murder, white collar offences.
11.	Serology	Blood, semen, saliva, other body fluids, skin tissues.	Rape, murder, assault.
12.	Toxicology	Viscera and body fluids, poisonous substances, drugs, intoxicating substances like alcohol, sedatives, barbiturates etc.	Suicide, murder, accident, mass disasters, food poisoning.

GLOSSARY

1. Expert witness
2. Locard's exchange principle
3. Scientific method
4. Chain of custody
5. Physical evidence
6. Rough sketch
7. Standard/reference sample
8. Identification
9. Individual characteristics
10. Class characteristics

LEARNING OUTCOME

After studying this unit you should be able to:

1. Define and differentiate between Forensic Science and Criminalists.
2. The major contributors to the development of Forensic Science.
3. Define physical evidence.
4. Define the various steps to be taken to thoroughly record the crime scene.
5. Define the various proper techniques for packaging common types of physical evidence.
6. Explain the steps typically required to maintain appropriate health and safety standards at the crime scene.
7. Define the common types of physical evidence encountered at crime scenes.
8. Differentiate between the identification and comparison of physical evidence.

SUGGESTED READINGS

1. Forensic Science in Criminal Investigation and Trials – Mr. B. R. Sharma.
2. Forensic Science in India – Mr. B. B. Nanda.
3. Introduction to Forensic Science in Criminal Investigation – Dr. R. Krishnamurty.
4. Complete Crime Scene Investigation – Mr. Everett Baxter.
5. Forensic Criminology – Mr. Wayne. A. Petherick.

UNIT II

LEARNING OBJECTIVES:

In this unit you will be introduced to:

1. The common ridge characteristics of a fingerprint.

2. The three major fingerprint patterns and their respective subclasses.

3. Visible, plastic, and latent fingerprints.

4. The concept of an automated fingerprint identification system (AFIS).

5. Techniques for developing latest fingerprints on porous and nonporous objects.

6. The proper procedures for preserving a developed latent fingerprint.

7. Classification of Footprints.

8. Hoof and Paw marks.

9. Gait patterns.

10. Skid Marks.

UNIT II-A- FINGERPRINTS

2.0 HISTORICAL PERSPECTIVE

Since the beginnings of criminal investigation, police have sought an infallible means of human identification. The first systematic attempt at personal identification was devised and introduced by a French pole expert, Alphonso Bertillion, in 1883. The Bertillion system relied on a detailed description (portrait parle) of the subject combined with full-length and profile photographs and a system of precise body measurements known as anthropometry.

The use of anthropometry as a method of identification rested on the premise that the dimensions of the human bone system remains fixed from age 20 until death. Skeleton sizes were thought to be so extremely diverse that no individuals could have exactly the same measurements. Bertillion recommended routine taking of eleven measurements of the human anatomy. These include height, each, width of head, and length of the left foot.

For two decades, this system was considered the most accurate method of identification. But in the first years of new century, police began to appreciate and began to accept a system of identification based on the classification of finger ridge patterns known as fingerprints. Today, the fingerprint is the pillar of modern criminalistics identification.

Evidence exist that the Chinese used the fingerprints to seal legal documents as far back as three thousand years ago. However, whether this practice was performed for ceremonial custom or as a means of personal identity remains a point of conjecture lost to history. In any case, the examples of fingerprints in ancient history are ambiguous, and the few that exist did not contribute to the development of fingerprinting technologies as we know them today.

Several years before Bertillion began work on his system, William Herschel, an English civil servant stationed at India, started the practice of requiring natives to sign contracts with the imprint of their right hand, which was pressed against a stamp pad for the purpose. The motives of Herschel's requirement remains unclear; he may have envisioned fingerprinting as a means of personal identification or just a form of the Hindu custom that a trace of bodily contact was more binding than a signature on a contract. In any case he did not publish anything about his activities until after a Scottish physician, Henry Fauld, working in a hospital I Japan, published his views on the potential application of fingerprint to personal identification.

In 1880, Fauld suggested that skin ridge patterns could be important for the identification of criminals. He told about a thief who left his fingerprint on a whitewashed wall, and how in comparing these prints with those of a suspect, he found that they were quite different. A few days later another suspect was found whose fingerprints compared with those on the wall. When confronted with the evidence, the individual confessed to the crime.

Fauld was convinced that fingerprints furnished infallible proof of identification. He even offered to set up at his own expense a fingerprint bureau at Scotland Yard to test the practicality of the method. But his offer was rejected in favor of the Bertillion system. The decision was reversed less than two decades later.

The extensive research on fingerprinting conducted by another Englishman, Francis Galton, provided the needed impetus that made police agencies aware of its potential application. I9n 1892, Galton published his classic textbook, Finger Prints, the first book of its kind on the subject. In his book, he discussed the anatomy of fingerprints and suggested methods for recording them. Galton also proposed assigning fingerprints to three pattern types –loops, arches, and whorls. Most important, the demonstrated that no two prints were identical and that an individual's prints remained unchanged from year to year. At Galton's insistence, the British government adopted fingerprinting as a supplement to the Bertillion system.

The next step in the development of fingerprinting technology was the creation of classification systems capable of filing thousands of prints in a logical and searchable sequence. Dr. Juan Vucetich, an Argentinian police officer fascinated by Galton's work, devised a workable concept in 1891. His classification system has been refined over the years and is still widely used today in most Spanish-speaking countries. In 1897, another classification system was proposed by an Englishman, Sir Edward Richard Henry. Four years later, Henry's system was adopted by Scotland Yard. Today, most English – speaking countries, including the United States, use some version of Henry classification system to file fingerprints.

Early in the twentieth century, Bertillion's measurement system began to fall into disfavor. Its results were highly susceptible to error, particularly when the measurements were taken by the people who were not thoroughly trained. The method was dealt its most severe notable setback in 1903 when a convict, Will West, arrived at Fort Leavenworth prison. A routine check of the prison files startlingly revealed that a William West, already in the prison, could not be distinguished from the new prisoner by body measurements or even by photographs. In fact, the two men looked just like twins, and their measurements were practically the same. Subsequently, fingerprints of the prisoners clearly distinguished them.

India has the proud privilege of being actively associated with the development of this basic science. It is said thousands of years before the birth of Christ, Chinese monarchs used finger impressions for official purpose of sealing important state documents, though this could perhaps have been more as part of a ritual or even ornamentation than for the purpose of identification. Clay seals were mostly used for sealing documents. Indus Valley civilization extensively used fingerprints embossed on clay tablets/seals. The use of fingerprints on seals clearly indicates their significance for identification purposes. Shahjahan's Royal hand seal on certain important documents is abundant testimony to the above fact. Fingerprints along with palm prints known as

PANJA were used for several centuries in Bengal. The history and development of fingerprint science as a means of identification of persons is really fascinating.

1.1 Pioneers

(a) Dr. Henry Faulds

- Dr. Henry Faulds who was a Scottish physician came to India as a medical missionary in 1871. Later while working at the Tsukiji Hospital, Tokyo in 1877, he got involved in the study of fingerprints.
- Dr. Henry Faulds noted that fingerprints could be classified and that ridge details were unique.
- It was Henry Faulds who first used printer's ink for recording fingerprints, a

practice in vogue even today.

- Dr. Henry Faulds was the first scientist to give the idea of tracing a criminal from a chance print at the scene of a crime.
- Dr. Henry Fauld's observations were recorded in a letter and published in the British Journal NATURE in its issue of 28th October 1880.

(b) Sir William Herschel

- Sir William Herschel who was an Indian Civil Service officer and collector of Hooghly district in Bengal is credited with being the first European to recognize the value of fingerprints as a means of identification of persons.
- Sir William Herschel's contribution to fingerprint science was to establish the fundamental, time tested principle of permanence of fingerprints.
- The first thumb impression ever recorded on a document was the historic contract under Herschel's instructions in 1877, of one Rajyadhar Konai who was a govt. contractor, having financial dealings with Herschel's office.
- Sir William Herschel wrote the famous Hooghly letter on the 15th August 1877, to the Inspector of Jails, Bengal in which Herschel recommended that persons committed to prisons would be fingerprinted to confirm their identities, a procedure so meticulously followed all over the world even today.
- Sir Herschel incidentally was the grandson of Kings Astronomer Herschel who is credited to the discovery of the planet URANUS.

(c) Sir Francis Galton

- Sir Francis Galton took up the study of fingerprints in 1890.
- Sir Francis Galton established the individuality and permanence of fingerprints as a scientific method of identification.
- Sir Francis Galton suggested that two fingerprints can be compared to establish their identity or otherwise with the help of those deviations from the regular continuous flow of ridges in a print, also appropriately known as Galton's details, which we now call Ridge Characteristics.
- Sir Francis Galton established that it was the appearance of a new ridge at a particular point, in relation to other points and not the way in which it appeared, that ultimately mattered in the actual comparison process.
- Sir Francis Galton published the first book on „Fingerprints‰ in 1892, which contained a method of classifying fingerprints into three major groups Arches, Loops, and Whorls.
- Galton's laboratory was unique and the first of its kind for the study of fingerprints.

(d) Sir Edward Richard Henry

- Sir Edward Richard Henry who was Inspector-General of Police, Bengal from 1891 devised a new system of classification of fingerprints, which with appropriate modifications and improvements is in use even today in most parts of the world. He published the book classification and uses of fingerprints in 1900.
- Sir Henry persuaded two of his subordinates, Khan Azizul Haque and Hem Chandra Bose in evolving the classification and sub classification of fingerprints on a mathematical basis, which was ultimately responsible for lexiconising the entire fingerprint records in the real sense of the term.
- The fingerprint system was first suggested by Dr. Henry Faulds, initiated by Sir William Hershel, developed in to a system by Sir Francis Galton and perfected and applied by Sir Edward Richard Henry for the benefit of the Criminal Justice

community.

- The first Fingerprint Bureau in the world was established in Calcutta in 1897 (12.06.1897).

2.1 TERMINOLOGY

i) Fingerprint - A fingerprint is a reproduction of the ridge formation of a finger on a surface.

ii) Principles
   - *Permanency* - the ridges formed even before birth do not change until and unless destroyed by decomposition after death.
   - *Individuality* - two fingerprints are identical only if they are both produced by the same finger of the same person.
   - *Theory* - it is a well-established truth that in nature there are no two exactly identical things. All forms of created beings are different from each other and are individually distinct.

iii) Formation of fingerprints - The palmer surface of the hands including fingers and the sole of the feet including toes, is covered with a special kind of skin termed friction skin. The peculiarity of this skin consists of it being formed by minute designed ridges. The ridges are formed through the lateral pressure between nascent structures. The ridges are first discernible in the fourth month of foetal life and are fully formed by the sixth month of pregnancy. Ridges appear earlier in the hands than on the feet. They appear first on the fingers and toes, then on the palm and sole.

iv) Friction skin - The covering of the bulb of the fingers and thumbs, palm of the hands and sole of the feet including toes is called friction skin.

v) Ridges - The narrow elevated lines on the friction skin are called ridges and they are studded with sweat pores.

vi) Furrows - Depressions between the ridges are known as furrows.

vii) Function of ridges
   - The corrugations strengthen the dermal structure and help to resist wear and tear.
   - They facilitate the process of exudation by keeping the sweat pores above the neighboring surface.
   - They perform the function of aiding the sense of touch.
   - They help to prevent from slipping when in contact with smooth surfaces, by giving appropriate elasticity to the skin.
   - They now form the basis of an individual identification.

viii) Sweat pores -The sweat pores run in single rows along the ridges and communicate through the sweat ducts with the sweat glands.

ix) Constituents of sweat -Sodium chloride, potassium chloride, fatty acids, amino acids, riboflavin, pyridoxine etc.

x) Minutiae or Galton's Details - The ridges are characterized by minute peculiarities such as, ridge endings, bifurcations, enclosures, dots, cross overs, spurs and short ridges. These variations from the regular continuous flow of ridges are called ridge characteristics and are used to establish identity of two prints.

xi) Frequency of ridge characteristics - Ridge ending: 47% Bifurcation: 22%, Enclosure: 10%, Dot: 9%, Cross over: 6%, Spur: 4%, Short ridge: 2%

xii) Pattern - Pattern is the design formed by the ridges in a fingerprint.

xiii) Pattern Area - Pattern area is that part of a pattern in which appear the core, the delta and the ridges used for classification.

xiv) Type lines - Type lines may be defined as the two innermost ridges which start parallel, diverge and surround or tend to surround the pattern area.

xv) Cores - Core is the innermost or central part or the heart of a pattern and the point of core also known as inner terminus (I.T) is a point in it. The core of a loop may consist either of an even or an uneven number of ridges termed rods not joined together at the top or may consist of two ridges joined together at their summit termed as staple. In whorls circular or elliptical, the center of the first ring is the point of core. In case of spiral, the point from which the spiral begins to revolve is the point of core.

xvi) Delta - A delta is a triangular plot which may be formed either by the bifurcation of a single ridge or by the divergence of two parallel ridges, these ridges forming the type lines.

xvii) In case of a delta formed by the bifurcation of a single ridge, the point of bifurcation forms the point of delta also known as the outer terminus (O.T) and when there are several such bifurcations, the one nearest to the core is taken as the outer terminus. This is known as a closed delta.

xviii) In case of a delta formed by the divergence of two parallel ridges, the nearest ridge in front of the place where the divergence begins, even if it is a mere point or is connected to any of the diverging ridges, is the outer terminus. This is known as an open delta.

xix) Ridge counting - The number of ridges that cut an imaginary line drawn from the delta to the core, neither the delta nor the core being counted, is known as the ridge count. If there is a bifurcation at the exact point of coincidence, two ridges are counted. Fragments and dots are counted if they appear as thick as the neighboring ridges. But ridges, which run close up to without meeting the line, are not counted. Subsidiary ridges are excluded from ridge counting and ridge tracing.

xx) Ridge Tracing - The course of the lower limb of the left delta ridge of a whorl is traced and when this meets the corresponding ridge of the right delta, the whorl is specified as ‘M’, when the ridge goes outside as ‘O’ and when the ridge goes inside as ‘I’. In practice, however ‘I’ actually means that the left delta ridge goes inside the right delta ridge with three or more ridges intervening, ‘M’ means the left delta ridge meets the right delta ridge or goes inside or outside the right delta ridge with less than three ridges intervening and ‘O’ means the left delta ridge foes outside the right delta ridge with not less than three ridges intervening. When the ridge whose course is being traced, stops short, the course of the ridge next below is followed. When the ridge bifurcates, the tracing proceeds along the lower line of bifurcation.

2.2 FINGERPRINT PATTERNS

(a) Arch

An Arch is a pattern is which the ridges run from one side to the other, slightly rising in the centre, making no backward turn. There is ordinarily no delta, but when there is the appearance of a delta, no ridge should intervene between the delta and the core. It is then called an arch approximating loop or a loop without count. An arch is also known as a pattern less pattern.

- *Tented Arch*

In patterns of arch type, the ridges near the middle may have an upward thrust arranging themselves as it were on both sides of a spine or axis towards which adjoining ridges converge. The ridges thus converging give the pattern the appearance of a tent and such a pattern is known as a Tented Arch.

(b)Loop

A Loop is a pattern in which one or more ridges enter on either side, take a diagonal upward course, recurve, touch or pass an imaginary line drawn between the delta and the core, and end or tend to end towards the same side of the pattern; there is one delta and a core and at least one ridge count.

Essentials of loops: One delta, one core, one recurving ridge, at least one ridge count between the delta and the core.

Loops are subdivided into ulnar and radial. A loop is said to be ulnar or radial, according to whether it slopes towards the ulna or radial bone, the radial being on the thumb side and the ulna on the little finger side. In ulnar loops, the ridges slant towards the right in case of right hand fingers and towards the left in case of left hand fingers. In case of radial loops, the ridges slant towards the left in case of right hand fingers and towards the right in case of left hand fingers.

In order to distinguish between tented arches and loops whose ridges have a vertical trend, it is stipulated that if on either side of the axis even one ridge recurves, the impression is a loop, but if there are recurving ridges on both sides of the axis, the impression is a tented arch.

- *Invaded loop*

This is a loop which presents the appearance as though a series of ridges are swarming over the pattern, coming from the delta side and threatening to engulf it from above.

- *Crested loop*

This is a loop is which the ridges swarming over the pattern are stopped along a line which they cannot pass or are swept in the current of normal ridges giving the appearance of a crest above the pattern area.

- *Nutant loop*

When the loop has the appearance of a sickle or a drooping flower, it is known as a nutant loop, also known as an indented loop.

(c) Whorl

A whorl is a pattern in which one or more ridges form a series of circles or spirals around the core, the circling ridges should make at least one complete circuit and there must be two deltas also. Whorls can be single cored, double cored, elliptical, spiral or almond shaped.

- *Composite*

A composite is a pattern in which combination of two or more patterns are found in the same print. These are subdivided into:

Central pocket loop:

In patterns of loop type, the ridges immediately about the core deviate in course from the general course of other ridges, making a pocket at the center.

The essential conditions are: a) there should be at least one looping ridge, b) the recurve about the core should be at right angles to the line of exit of the looping ridges, c) line joining the deltas should not cut any of the recurving ridges, d) there should not be more than five recurving ridges.

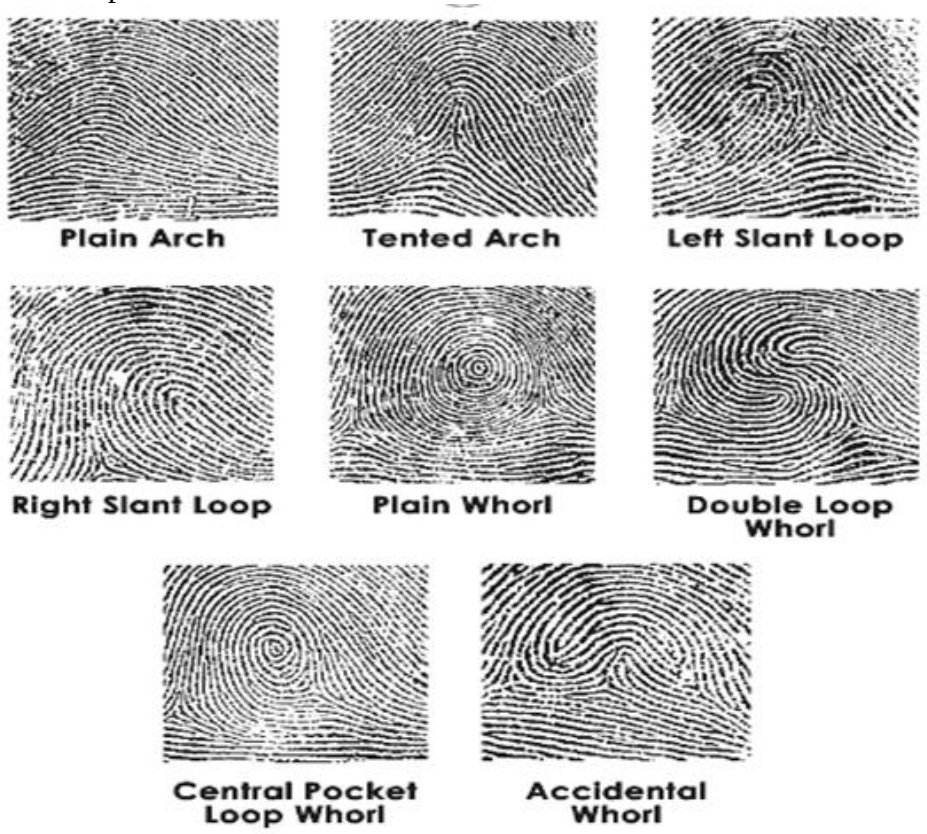
A central pocket loop may be formed in the following four different ways namely ring, spiral, hook and concave.

Lateral pocket loop:
When the ridges constituting the loop bend sharply on one side before recurving, thereby forming on that side an inter space or pocket usually filled by the ridges of another loop, such an impression is termed a lateral pocket loop.

Twinned loop:
An impression which at first sight appears to be complicated, but which really consists of two well defined loops one surrounding or encircling the other, is a twinned loop. In lateral pocket loop, the ridges containing the points of core have their exits on the same side of either deltas, while in twinned loop the ridges containing the points of core have their exits on different sides of either deltas.

Accidentals:
Accidentals are combinations of two or more patterns too irregular in outline to be grouped in any other pattern. An arch with pocket is also included in this group.

Frequency of patterns
Arches: 4.2%
Tented arches: 2.8%
Loops: 61%
Whorls and composites: 32%.



2.3 TAKING OF FINGERPRINTS

- *Materials & Methods*

The equipment generally used for taking fingerprints consists of black printer's ink, an inking slab/plate, rubber roller with handle, magnifying glass and fingerprint slips.

When the finger comes in contact with an inked surface, only the ridges pick up the ink. On rolling the inked finger on the slip, the ridges are reproduced as they appear on the finger.

A small quantity of printer's ink is applied on the inking slab/plate and then made into a thin uniform film with the help of the roller. The thumb or finger to be printed is than placed on the of slab/plate and rolled from one side of the nail to the other. By pressing the inked thumb or finger lightly on the slip and rolling it exactly in the same manner, a reproduction of the ridges of the finger in ink is obtained on the slip. This may be done starting from the thumb and then in the order, index, middle, ring and little fingers of first the right hand and then the left hand in their respective slots.

- *Rolled impression*

Rolled impressions are obtained by inking the whole of the ridge system and rolling the thumb or finger from one side of the nail to the other. The rolled impressions are more important as they furnish a wider field for the purpose of classification and comparison.

- *Plain impression*

Plain impressions are taken by pressing the inked bulb of the thumb or/and fingers together in their natural sequence, without any rolling movement being made. Plain impressions are used to check that the rolled impressions are taken in their proper order. These are also used for comparison with the chance prints as the plain prints more closely approximate the impressions left at the scenes of crime or on crime articles in shaped and size. They are also occasionally useful in classification when the rolled impressions are not clear or are distorted.

Precaution for taking of fingerprints

- The slab and the roller must be free from dust and dirt.
- The slab and the roller should be properly cleaned before use.
- Only a small quantity of ink should be applied.
- Excessive pressure should be avoided.
- The thumb should be rolled towards the body and the fingers away from the body.
- The fingers should not be rolled over the same part of the slab until it is re-rolled with ink.
- Fingers should be cleaned of dirt and dried of perspiration.
- Fingers should be rolled fully from one end of the nail to the other; fingers should not be allowed to slip or twist.
- The rolled impressions should show the complete contour of the finger so that the ridge counting and tracing can be done easily and correctly.

- Impressions should be taken in the space allotted for that finger.
- If a finger is missing or so deformed that it is impossible to obtain an impression, the fact should be noted in the space allotted for that finger.
- Fingerprints of lepers should never be taken.

2.4 TAKING OF PALM AND SOLE PRINTS

(a) Palm Prints

In taking of palm prints, the inking slab should be large enough to cover the entire area of the palm, on which ink is spread thinly by means of a rubber roller. Then the palm is inked by pressing on the inked slab, and the print is obtained by pressing the inked palm on a paper placed in a similar manner as plain fingerprints are taken.

(b) Sole prints

In taking of sole prints, the inking slab should be large enough to cover the whole area of the sole. Press the foot on the inked slab and then press it on a paper in the same way as plain fingerprints are taken and a sole print is thus obtained.

2.5 TAKING FINGERPRINTS OF DEAD BODIES

Where the identity of a corpse or of a person killed in an accident or who has died under suspicious circumstances or in the act of committing a crime, has not been fully ascertained by ordinary investigation, the fingerprints of the deceased are taken to trace the identity.

Those who have died presently and rigor mortis has not set in, the process of fingerprinting is quite simple. If the fingers are entirely flexible, prints can be taken as usual. If the fingers are not flexible, a little massage of the fingers will make them flexible.

The dead bodies where rigor mortis has set in, the same can be overcome temporarily and the finger impressions can be taken easily. Apply ink thinly on the fingers with the help of a rubber roller or spread in thinly on a spatula or a blunt knife and then ink the fingers by rolling it over the fingers. Fix a square paper on the broad side of wooden pad and roll the wooden pad from one side of the finger to the other. The prints of the fingers can then be pasted on a fingerprint slip in a sequence format.

When decomposition has already set in:

(a) When the skin is shrunken and hard, the fingers should be treated with a dilute solution of sodium hydroxide. The dried and crimpled skin regains its normal shape due to swelling by the absorption of the solution. It is then dried inked and printed. If the flesh is found to be too soft, it should be treated with alcohol or formaldehyde for hardening. If the fingers are saturated with sodium hydroxide and are too wet, the fingers should be treated with acetone then dried, inked and printed

(b) When the body is in an advanced stage of decomposition, plastic regeneration of digital extremities is helpful. This is done by injecting liquid Vaseline, hot water, glycerin or melted paraffin wax into the bulb of the finger through a very fine needle till the finger reaches its original shape and size. The fingers are then carefully inked and printed.

(c) Air is injected through a very fine needle as in the above case, till the digital bulb is conveniently inflated and the prints are then taken.
(d) When the flesh is soft and flabby and the outer skin also soft and fragile, the skin should be carefully removed from the finger (autopsy surgeon) and hardened in fifteen percent formaldehyde solution for about and hour, then dried, inked and printed.
(e) when the skin tissue is so badly decomposed, X-ray photography is useful. The procedure is as follows:

The X-ray opaque medium – bismuth carbonate or lead carbonate is applied to the inner surface of the fingers and distributed by gentle massage so as to fill in the depression only. The excess is wiped off and photograph taken by usual X-ray procedure. In the photograph these depressions will be shown as white line and ridges as black.

If the fingers are dried and shriveled due to excessive heat or when burnt they should be kept in a strong solution of ammonia, till they appropriate their natural condition. The fingers are then washed, dried, inked and printed as described below.

Procedure:

1. Place a fingerprint slip strip in the strip holder (spoon).
2. Using the spatula, ink the finger (starting with the right thumb) from nail to nail.
3. Place the inked finger on the fingerprint slip strip holder (curved area) and press down. Do not roll the finger. The curved shape of the holder will serve the same purpose as rolling the finger.
4. Cut out the finger block from the slip strip and paste in the corresponding block on the standard fingerprint slip.
5. Repeat these steps for each of the remaining fingers. Be sure to record the correct finger in the correct finger block.

If proper facilities are not available at the place where the dead body is recovered, the epidermal skins removed should be carefully preserved in ten separate labelled bottles (right and left distal phalanges) containing suitable preservatives (glycerin, formalin and water 1-2-5 proportion) and brought to the Bureau for recording the prints. The bottles should necessarily be sealed air tight, so that the skin remains in the solution till the bottle is opened. In view of the risk involved of getting seriously infected while fingerprinting a cadaver, necessary precautions must be taken while taking fingerprints of the dead body, including use of gloves. Immunization for hepatitis B and B.C.G inoculation for tuberculosis are recommended for those who often take fingerprints of cadavers.

2.6 ROLE OF FINGERPRINTS IN DISASTER VICTIM IDENTIFICATION

All living beings depend upon the mercy of nature and are often subjected to the vagaries of it when disaster strikes, such as earthquake, floods, and tsunami, and the manmade disaster like air crash, ship wreck, railway accident, fire, chemical release and the like.

In such unforeseen calamities, a mass of innocent population gets affected and requires proper identification of persons who lose their lives, for insurance claim, by the next of kins, financial assistance to the dependents etc. etc.

Fingerprints are the best means for identification of disaster victims. Fingerprint expert play a vital role in such situations. The experts in groups may visit such sites depending upon the estimated number of the dead/wounded. The services of specially trained fingerprint experts with adequate infrastructure to record clear and identifiable fingerprints can e made available.

The ultimate aim of all disaster victim identification operations must invariably be to establish the identity of each and every victim by comparing and matching ante-mortem and post-mortem data of fingerprints.

2.7 PURPOSE OF TAKING FINGERPRINTS

- For permanent record, on being convicted by a court of law.
- For search in the records to establish identity and to ascertain previous criminal history, on arrest in connection with a crime.
- To establish identity of unidentified dead bodies including disaster victim.
- For use in place of or in addition to signatures.
- For comparison with chance prints developed from the scenes of crime or on crime articles.
- For comparison with questioned prints on documents.

Applications: A part from forensics application of fingerprints include the following areas: Passport, Driving license, Banking, Electronic voting, Competitive examination, Employment registration, Insurance and Access control etc.

2.8 FINGERPRINTS AT THE SCENE OF CRIME

Scene of Crime

One of the most important contributions science has made in the investigation of crime is the development of chance prints left behind by criminals at the scene of crime or on crime articles and their identification. As these prints come directly from the body of the person, their development and identification help to establish his physical presence at the scene of crime. A fragment of a chance print with adequate matching points found at the scene of a crime or on a crime article, as long as it is inconsistent with innocence, is considered sufficient to sustain a conviction.

At the scenes of crime, experts use various techniques, modern equipments and multiple light sources to develop the chance prints and photograph them which are then compared with specimen/admitted fingerprints.

If the crime is a murder, the manner of committing the murder may indicate the field of search. Thus, in a case of suspected poisoning, glasses, bottles, cups, saucers, spoons, etc., should be examined. If the victim was shot, firearms, fired cartridge cases, unfired cartridges, cartridge boxes, and tables where arms and ammunitions were possibly kept, are to be looked for. If the victim was stabbed, all pointed or sharp edged weapons are to be examined. All objects which may have figured in the quarrel preceding the crime or during the commission of the crime or objects used by the criminals to destroy evidence prior to or during their flight from the scene of crime should be meticulously examined. It is the rich experience and the imaginative and practical approach of the expert that makes all the difference.

Scene of crime prints

Fingerprints found at the scene of crime may be broadly divided into three kinds. Visible prints

Prints visible to the naked eye formed by fingers stained with some coloured materials such as blood, ink, paint, dirt etc. are known as visible prints. These prints usually need no development and can be photographed straightway.

Plastic prints

Plastic prints are formed when the finger touches or presses against a plastic or pliable surface or a dusty surface in such a way that a negative cast of the ridge formation is produced on that surface. These prints also generally need no development and are straightway photographed.

g. melted wax, freshly painted surface, a thin layer of dust etc.

Latent fingerprints

Latent fingerprints may be defined as those markings usually rather indistinct, left by oily matter or perspiration exuded from the fingers on any smooth and absorptive surface, which the fingers may have touched.

When the fingers come in contact with a smooth and absorptive surface, certain substances in the sweat are transferred from the ridges to that surface resulting in the formation of latent fingerprints.

Fingerprint developing kit

- When visiting a scene of crime, fingerprint experts carry with them a latent print developing kit consisting of variety of powders and brushes, lifting materials, magnifying glass, flash light, two pairs of gloves, one pair of scissors, one pocket knife, one tape, fingerprinting kits and slips.
- Modern fingerprint developing kits are available in the market. Scene of crime fingerprint development

The selected powder is lightly applied to the suspected surface with a fine fingerprint brush. The brush is applied first in one direction and then in the other and when the ridges start appearing, the brushing is done in a way that its motion follows the flow of ridges. When sufficient powder adheres to the impression, the excess powder is carefully brushed away with a light soft touch of the brush or by light tapping. The developed prints are immediately photographed after appropriate marking and initialing.

Physical method of fingerprint development

A variety of fingerprint powders with different compositions and in various shades are available in the market. The most commonly used powders are black and grey powders. The black powders are used for developing prints on light coloured surfaces and grey powders are used on dark coloured surfaces to get maximum contrast.

When latent prints are to be developed on a multicoloured surface, a fluorescent powder can be applied. The prints developed with fluorescent powder glow under U.V rays and can be photographed on an ordinary black and white film. Varieties of frequently used

powders are gray powder, white powder, aluminium powder black powder fluorescent powder and magnetic powder.

Chemical method of fingerprint development

Iodine Fuming Method: Development of latent fingerprints by iodine fuming method is perhaps the oldest method of developing latent impressions on porous surfaces especially on documents and the method still continues to have an important place in fingerprint work. When iodine crystals are subjected to moderate heat, they vaporize, producing violet coloured fumes. When the fact and oil deposits of the latent impressions come in contact with the iodine fumes, prints become visible in yellowish brown colour. The prints developed with iodine fumes are not permanent and they begin to fade as soon as the fuming is withdrawn and therefore, when they appear in full intensity, they should be photographed straight away.

1. Use steam to make the prints deeper in colour 2. Use starch solution for permanent fixation of the developed prints.

Cyanoacrylate Fuming Method: Cyanoacrylate fuming has been successfully used for the development of latent prints on surfaces as diverse as plastics, electrical tape, garbage bags, Styrofoam, carbon paper, aluminium foil, unfinished wood, rubber, cellophane and smooth rocks. Place three drops of liquid cyanoacrylate in a small porcelain dish, and place the dish in the fuming cabinet, allow the item to be exposed to the fumes for at least two hours until white coloured fingerprints appear. The prints can be further enhanced by dusting with regular or magnetic fingerprint powder or with appropriate dyes.

Ninhydrin Technique: The development of latent fingerprints with ninhydrin is based on the chemical reaction of ninhydrin with amino acids, which are present in the sweat. Normally a 3% solution of ninhydrin is used which is prepared by dissolving 3gms of ninhydrine in 100cc acetone or ethyl alcohol. This solution may be applied to the surface by spraying or dipping. The drawback is that the ink writing on the document is destroyed during the process, this drawback can however be overcome by the following technique.

Two semi absorbent papers are soaked in the solution and allowed to dry for a few seconds, the document to be examined is sandwiched between these papers and kept in a dry mounting press at medium temperature for 15 to 20 minutes. Pink to purple coloured prints are developed which are permanent and can be preserved for several months. When the developed prints reach their full intensity, they are photographed. The advantage of ninhydrine technique is that it is successful even on very old prints.

Silver Nitrate Method: This method is based on the fact that the sodium chloride of the deposited perspiration in the latent impression reacts with silver nitrate to form silver chloride, which is light sensitive and breaks into its components silver and chloride. The fingerprints developed with silver nitrate solution appear reddish brown in colour. A five percent silver nitrate solution is generally used for this purpose. The silver nitrate method is useful for developing latent prints on paper, cardboard and raw unpainted wood. Silver nitrate solution can be applied by brushing, spraying or by dipping in the

solution. When the ridges start appearing, the exhibit is removed and photographed straight away as the whole surface is likely to be coloured in due course.

Iodine fuming should precede the ninhydrin technique as fats and oils are soluble in acetone and ether; similarly ninhydrin technique should precede the silver nitrate technique, as amino acids are soluble in water.

Lifting of Fingerprints

When it is possible to develop a print, but not photograph it effectively due to the physical location of the print, or reflection of light or when the print is on a multicoloured or very heavy object, the print is lifted away using appropriate lifting tapes.

Technique

After the latent fingerprint has been developed with suitable fingerprint powder, the sticky surface of the fingerprint lifter, selected according to the surface of the object and colour of the powder used, is pressed against the developed print in a careful manner. After the lifter has been uniformly pressed over the developed print, it is carefully peeled off from the surface and straight away pressed on a plastic sheet, ensuring no air bubbles. Specially made fingerprint lifting tapes and plastic sheets are now available in the market. All procedural formalities should be strictly adhered to, while lifting chance prints at the scene of crime.

2.9 EXPERT AT THE SCENE OF CRIME

On receipt of the message regarding a crime scene visit, instructions be sent that the scene of crime is left undisturbed and two independent witnesses be arranged. On arrival with the forensic photographer, the scene may be photographed without moving or disturbing any thing. Expert examining the scene should also be photographed.

A careful description of the scene of crime preferably along with photograph is always helpful. A meticulous survey of the scene of crime in a clock wise or anticlock wise direction should then be made before starting the examination for prints. All articles suspected to have been touched or handled should then be carefully examined for chance prints. Place of entry and exit, doors windows as well as glass panes, almirahs, tabletops, cash and jewellery boxes, mirrors, any smooth and absorptive surface which could have been handled or touched, should all be then examined. Any weapon, tool used for house breaking, torch etc possibly left behind should also be looked for. The nature of the crime and the manner in which it was committed generally decide the scope of examination for fingerprints at the scene of crime. Where fire arms were used cartridge cases etc, suspected poisoning, bottles or glasses and in case of stabbing, sharp edged weapons and above all blood stained prints if any, are to be carefully searched for.

In case of blood stained prints, sample blood should be taken by the concerned expert, for serological examination preferably without affecting the comparable area of the print. The fact that the print at the scene of crime was identical with that of the accused and that it was blood stained and of the same group of the deceased/injured becomes

crucial if the accused can claim reasonable access to the scene of crime. (A person can be accused of a crime using fingerprints as an evidence, only if that evidence is inconsistent with his innocence).

If prints are available in a thin layer of dust, it is advisable to have the same photographed straight away. Such prints may however be preserved by spraying a solution of cellulose acetate which after getting dried and firm may be peeled off and sand witched between two plastic sheets with signatures and preserved to be used as exhibits during trial.

Efforts should then be made for development of latent fingerprints using appropriate powders depending on the surface. The selected powder is lightly applied to the surface with a fine fingerprint brush. The brush is applied firstly in one direction and then in the other and when the ridges start appearing, the brushing is done in such a way that its motion follows the flow of ridges. When sufficient powder has adhered, the excess is carefully tapped or brushed away. The developed prints are then marked, initialed and photographed. fingerprints of the deceased, injured and the inmates should invariably be taken for comparison and elimination. The exhibits containing the chance prints developed and photographed should there after be carefully packed and sealed and taken to the Bureau to be finally sent to the investigating officer of the case along with the report.

Packing of exhibits

Irrespective of the method employed, it should be ensured that the surface bearing or believed to be bearing the chance prints does not come in contact with the packing material. It should also be ensured that the exhibit is securely packed in suitable container so that it remains stable against any jolting during transit. The primary consideration when packing exhibits is to safeguard them.

Precautions

Cotton or clothes should never be used in direct contact for wrapping exhibits bearing chance prints. Instead of nails, screws should be used during packing so that no damage is caused to the exhibits during unpacking. Use gloves while packing. Flimsy containers should be avoided for packing the exhibits.

2.10 FINGERPRINT PHOTOGRAPHY

- Photography plays a very important role in the entire fingerprint profession. In photographing the scene of crime, the expert should endeavor to provide maximum useful information which will enable the viewer to understand the relationship of the various objects, and may lead to show how the crime was committed.
- Photography as a proof to the fact that the expert did visit the scene of crime and developed the chance prints.
- Photography of the chance prints so developed including the objects/articles from which the prints were developed.
- Preparation of diapositive of prints so developed if the prints were developed with gray, aluminium, or white powder.
- Application of suitable photographic techniques when the prints were on a pliable surface, on a thin layer of dust causing negative prints (diapositive), or

on a coloured surface using appropriate filters.

- Photographic aspects of fingerprint identification, when the impressions are recorded in stamp pad ink on revenue stamps or the impressions are recorded in fountain pen ink or excessive stamp pad ink often resulting in negative impression.
- Preparation of photographic enlargements of the chance prints/questioned prints and specimen prints for marking the matching points, which is an essential requirement in an expert opinion of fingerprints.

2.11 COMPARISON OF FINGERPRINTS

The first attempt at comparing two fingerprints is generally directed to a rough general examination of their respective patterns. And if they do not agree in being of the same pattern, there is no doubt that the prints are of different origin. If the prints agree in being of the same pattern, the sub pattern if any, the formation of delta and core, tracing and counting etc. should then be examined. If these pattern characteristics are also found to match, the next step would be to examine the various ridge characteristics in detail as their successive coincidence throughout would be the ultimate proof if identity of the prints.

Ridge characteristics may be defined as those deviations from the regular continuous flow of ridges in a print, which impart individuality to a print, and which help to establish the identity or otherwise of a given set of prints. e.g. ridge endings, bifurcations, enclosures, short ridges, cross overs, dots etc. Fingerprint expert look for and rely mostly on these minute details of ridge structures to effect identification. Typically these minute details known as minutiae are mostly ridge endings and bifurcations or their different forms.

Their relationship with each other and with adjacent ridges is unique as far as the number of intervening ridges is concerned, but they may vary both in direction and dimension. The human palm including fingers and the sole of the foot including toes, is soft and pliable and therefore changes its shape slightly, when pressed or rolled to make a print. With each different impression, this plastic deformation generally effects changes in the absolute distance between any given pair of minutiae.

It however does not alter their topological relationship with each other or with adjacent ridges and it is this topological invariance that is crucial to the entire identification process. In other words, it is the number of ridges intervening between a pair of points that is given due weightage and not the actual distance or exact direction between a given set of points in two prints.

In order to make an exhaustive comparison of two prints, the characteristics should be traced ridge by ridge and some prominent points of reference should be identified and marked. Impressions on some article are sometimes found to have been left hurriedly and unconsciously and being generally in dust or dirt of some kind combined with excretion from the skin are not naturally as clear and comparable as impressions deliberately taken with ink by professionals. In such cases, occasionally the latent and inked impressions may show apparent variations which may occur, where a difference in pressure, application of powder or related conditions would affect them. This is equally true with thumb impressions recorded on documents. Because of the variably

printing pressures on the soft and elastic flesh of the fingers, palm etc, it is not always possible to make absolutely identical prints from the same source. But absolutely identical prints are not essential for making an identification. What is actually necessary is a record extensive and clear enough to convey the true message which such an impression is capable of delivering.

When two impressions are compared and sufficient characteristics appear in their nature and relative positions, the identity of prints is established beyond doubt. But the ridge characteristics in the different impressions of the same finger may have assumed different forms as a result of difference in pressure and other related conditions referred to above.

It is sometimes found that dirt on the inking slab causes a hiatus in a ridge, which leads to the commencement of a new ridge being found in a print, where a bifurcation appears in the corresponding part of the comparison print. Similarly too much ink or pressure may cause a continuity where there should be a hiatus. An island may by running of the ink appear as a bulging or thickening of the ridge. The one important point in making comparison is to remark the place where a new ridge begins it appearance because the manner in which it begins to appear is secondary. It therefore follows that when a fork in one impression corresponds to the sudden appearance of a new ridge in the other, the event is to be treated as an agreement and not a disagreement (Sir Francis Galton).

In an imperfect impression where neither the delta nor the core is present and in which only some meager details of ridges in a small portion of the pattern are available, one of the few ridge characteristics in the imperfect impression should be taken as the starting point and in relation to that point, the positions of one or two available points should be fixed. An attempt should then be made to look for these points in succession in the comparison print and by their help exactly to fix the particular plot to which they belong. Using a prominent ridge characteristic as the starting point, the number of ridges intervening between that point and the related characteristics, usually eight such, should be counted in any one direction to verify their positions and sequence of positions in relation to other characteristics. And once this is done, identity of the print is established.

2.12 THUMB IMPRESSIONS ON DOCUMENTS

When documents bearing questioned fingerprints are received for comparison, they are first checked as per forwarding letter along with the queries. Each fingerprint is then stamped and marked before the preliminary examination is done.

In preliminary examination, the questioned fingerprints are compared with the relevant specimen finger prints as per questionnaire. The questioned prints along with specimen prints are then sent for photography and preparation of enlargements of identical prints. On receipt of photographic copies of the prints, the final report is prepared accordingly.

Matching ridge characteristics are marked with projected red lines on the enlarged photographs. After marking the matching points their detailed descriptions are prepared. These photographs with detailed descriptions form the basis of the opinion that the prints are identical.

Photographic enlargements may be supplied along with reports, even when the prints are different, if the pattern characteristics tend to give the impression of an identity.

2.13 COMPARISON OF FINGERPRINTS USING MODERN TECHNOLOGY

Fingerprints have been in use in criminal investigation for personal identification for more than a century now. The increase in crime, together with, the consequent increase in criminal records, have made the manual comparison and identification a very difficult task. The manual system of fingerprint identification was not able to keep pace with the enormous increase of the FP records and the ever increasing number of queries required to be answered every day. The need for an Automated Fingerprint Identification System (AFIS) was, therefore, felt by the Police officers and Fingerprint Professionals the world over.

In India Automated Finger Print Identification System (AFIS) was first installed at the Central Finger Print Bureau of the National Crime Records Bureau in 1992. It uses image processing and pattern recognition technique to capture, encode, store and match fingerprints in both single digit as well as ten digit prints.

It has become an important aid to finger print experts in their day-to-day work of updating and querying on large database of fingerprints.

Facilities provided by AFIS

A fully functional Automated Fingerprint Identification System provides the following facilities.

1. Database creation
2. Identification oriented query
    a. Ten print to Ten print search.
    b. Chance print to Ten print search.
    c. Ten print to Chance print search.
    d. Chance print – to – Chance print search.
3. Remote Query Processing
4. Creation of Criminal Attribute Database

The AFIS offers the following:

1. Automated ten print search. (The trace percentage not to be less than 98.).
2. Automated replacement of better quality prints.
3. Automated pattern recognition.
4. Automated ridge direction determination.
5. Automated minutiae, core and delta detection and extraction.
6. Automated minutiae quality assignment.
7. Automated capture of logical rolled print area.
8. Automated capture of logical plain print area and comparison of plain prints

with rolled prints.

9. Automated selection of matching digit.
10. Full range of integrated chance print and ten print image enhancements.
11. Manual editing of minutiae and core/delta location(s) and direction(s).
12. Facility to re-edit chance print images without requiring a re-scan.
13. Facility to launch secondary searches.
14. Secondary/temporary database for document case examination.
15. Rotation of chance print images.
16. Side-by-side comparison.
17. User defined search filters.
18. User defined candidate thresholds.
19. Integration of AFIS with personal information system.

AFIS Processes

1. Input or Acquisition or Enrolment
2. Matching
3. Verification
4. Data Updation

1. Input or Acquisition or-Enrolment

Flat bed scanners are used for input of Ten digit Record and Search Slips and for Chance Prints. A unique number called the Personal Identification Number (PIN) is generated by the system and a label bearing this number is pasted on to the finger print slip or behind the Chance Print photograph. The Ten-digit/Chance print is placed with the probable orientation on the scanner bed and is subjected to preview scan if required to confirm the print position followed by high resolution scanning. As per the prevailing international standards, the scanning resolution for AFIS is 500 dpi (dots per inch).

Encoding takes place immediately after the high resolution scan. The features extracted by the system are:

a) Pattern class and alternate pattern class
b) Core and Delta points
c) Minutiae (ridge end points and bifurcation points)
d) Ridges
e) Smudge area

For each minutia, the following details are extracted.

(i) Location of Minutiae
(ii) Direction of minutiae
(iii) Relationship with neighboring minutiae in respect of ridge count, angle and

distance between them. In chance prints, editing of minutiae and ridge should be done very thoroughly although in some AFIS this feature is also automated. The background and smudged areas of the prints are eliminated by selecting the area of interest. The full range of image enhancement tools available must be utilized to get the best possible image, while selecting the area of interest.

2. Matching

The basic features used for finger print matching are the minutiae. Each minutiae is characterized by its coordinates, the direction of the ridge flow at the location of the minutiae, the ridge counts between itself and its nearest neighbors. The system extracts the minutiae of each fingerprint automatically. These extracted features represent the fingerprint's uniqueness. Whenever a fingerprint is to be identified, the system compares the characteristics of the minutiae of that fingerprint against the characteristics of corresponding minutiae in each of the fingerprint in the database. It is possible to restrict the search to a small group of fingerprints using parameters such as finger print code, region, and sex. The result of matching is a shortlist in the descending order of probability.

3. Verification

In verification, the expert compares a search finger print against short-listed finger prints from the database and identify the right match. Finger Print images are presented to the expert in the form of split screen display – the search print on one half of the monitor and the short listed print retrieved from the system on the other. The user can select the prints from the shortlist as required. Once the expert is satisfied about the identity, he/she marks it as TRACED or else it is marked as UNTRACED.

Facilities, such as zooming and marking of the identical minutiae, generating Grounds of Opinion etc are provided during verification.

4. Data Updation

Record slips are updated and stored in the database. If the finger print slip is a new one, the transaction is added to the database and is stored on hard discs. In case a duplicate is already present in the database, the system itself compares the quality of prints of both the slips and the better quality print replaces the other. The old PIN is retained.

Creation of Criminal Attributes Database

Criminal attributes such as name with aliases if any, parentage, sex, age, address etc. are stored in the data base. The database contains all the conviction details i.e. data of conviction, court, section, sentence, P.S. FIR No. etc. Information regarding absconders and death reports are also stored.

Before fingerprint data of criminals is entered in the database, the system can conduct a search by name for a possible duplicate. Queries by other details such as P.S., Regular Criminal Number, Provisional Criminal Number etc. are also possible on this data.

This database can be customized to suit individual needs of a Bureau by including additional information.

Advantages of AFIS

i) Diversifying the functioning of Finger Print Bureau through better utilization of expert manpower.
ii) Better management of fingerprint data.
iii) The entire database could be searched against chance prints.
iv) Replacement of poor quality prints with better quality prints.
v) Less physical handling of finger print record, thus protecting original record from wear & tear.
vi) Matching is automatically done by the computer, at a high speed, thus substantially reducing the search time.
vii) Networking of AFIS at different levels possible.
viii) Automatic enhancement of poor quality prints.
ix) More accurate compilation of Statistics.

2.14 ROLE OF FINGERPRINTS IN BIOMETRICS

- The term Biometrics is derived from the ancient Greek words bios for life and metric for measure.
- Biometric is the science and technology of authentication by measuring the person's physiological or behavioral features.
- Biometrics has also been used to the emerging field of technology devoted to identification of individuals using biological traits.
- Conventional biometric techniques are based on measuring and analyzing human physiological characteristics such as fingerprints, eye retinas and irises, facial patterns and behavioral attributes like voice, signature, gait etc. for authentication purposes.
- Biometric security solution is based on both physical and behavioral attributes. Physical attributes: Fingerprint, Face, Iris, and Retina

Behavioral attributes: gait, voice and signature.

- Biometric systems have the potential to identify individuals with very high degree of accuracy. Fingerprints have been in use as a branch of forensic science and have a long history of successes. Other biometrics are making way into practical applications in this field.

Fingerprint Biometric procedure

- Acquisition (or) Enrolment

Fingerprint biometric unit consists of a scanner. The scanners are many types; flat bed scanner, live scanner etc. The flat bed scanner is used for capturing inked fingerprints on paper. The live scanners generate digital image directly from a finger placed on the sensor. Biometric data is analyzed or processed to extract each minutia, location of minutiae, direction of minutiae, and relationship with

neighboring minutiae with respect to ridge count. This information is used to build a template for fingerprint storing and matching.

- Matching

In this unit, a given template is compared against one or more templates of the biometrics. The output of matching could be a short list of probable matches in the descending order or probability. Short list is analysed and a decision is taken in this unit. If the short list contains only one entry, it indicates a possible match. If there is more than one entry in the short list, then there could be duplicates or similar looking templates, which may be seen by the expert to take a decision on identification.

Biometric Applications

Biometric modes can be employed inter changeably for a large number of applications:

- Fingerprint authentication is extensively used in forensic application, computer network security, banking etc.
- Iris and Retina based biometric system can e used for access control applications involving high-level security.
- Face identification can be employed in surveillance, social welfare, and crime detection.
- Voice is the only biometric which can be used for identity validation over the phone.

The list of probable applications utilizing various biometric scan modes is ever increasing.

2.15 FORGERY OF FINGERPRINTS

A forged fingerprint is one that has not been recorded on the surface on which it appears, directly from the finger to which it belongs. It can also be defined as a fingerprint that has been reproduced or transferred from one surface to another to implicate a person without his knowledge. This is usually done with the help of certain photographic techniques or by using rubber or metallic stamps. It is impossible to forge a fingerprint successfully.

The following points are usually noticed in a forged impression:

- Abnormal condition of ridges
- Smudged and broken appearance of ridges
- Hazy and unreal formation of the points of similarity
- Obliteration of certain points of similarity
- Exact correspondence of the impression in shape, size and symmetry
- Absence of sharpness, life and warmth of the ridges
- Appearance of poorly defined pores or their non-existence

- Unusual appearance of the edges of the ridges. Detection of forgery:
- Examination of the nature and positions of pores under a microscope
- Examination of the presence of extraneous matter under u-v rays
- Chemical examination for the presence of extraneous matter
- Absence of any inking medium
- Peculiar appearance of the edges of the ridges.

2.16 DISSIMILARITIES IN IDENTICAL FINGERPRINTS

Two fingerprints are identical and are produced by the same finger of the same person if they both contain identical ridge characteristics in their relative positions. When two fingerprints are said to be identical, it is not claimed that they are identical in very respect. In fact, two identical prints cannot ordinarily and need not necessarily be exactly identical in all respects (one an exact replica of the other). Exact identity of two prints can be expected only if one of them is reproduced from the other or if both are reproduced from one print.

Differences are bound to occur in the general appearance of the prints, pattern characteristics, formation of ridge characteristics, thickness of ridges, geometrical distance and geographical direction between matching points etc., etc. These differences are due to improper inking, incomplete printing, uneven pressure, distortion, slipping or twisting of the finger, presence of foreign material on the finger or on the printing surface, presence of foreign material on the finger or on the printing surface, crease/injury/occupational marks present in one of the prints, application of developing powder with a brush, unnatural position in which a chance print is recorded, curvature of the receiving surface etc., etc.

Differences do occur even between two inked prints of the same finger taken moments apart. Any expert can find numerous differences between a plain print and a rolled print of the same finger, yet that does not mean that two were not made by the same digit so long as there is sufficient number of matching characteristics to establish a positive identification. (Edgar Hoover, Fingerprint and Identification Magazine, 1969 Issue, Page-4).

Sir Francis Galton one of the pioneers of fingerprint science, laid stress upon the importance of noting the place where a new ridge begins rather than the manner in which it begins and suggested that when a bifurcation in one print corresponds to the appearance of a new ridge in the other, the event is to be counted as an agreement and not a disagreement. (Chatterjee, Finger, Palm and Sole prints, 1967 Edition, Page-125).

The identical relationship of prints from the same digit ends with the sequence of the ridge characteristics. Prints of the same finger, no matter what the method of recording these may be, cannot be identical in every respect. (Cherril, The Fingerprint system at Scotland Yard, 1954 Edition, Page – 108).

Fingerprint Identification is made by observing that two impressions have ridge characteristics of similar shapes, which occupy the same relative positions in the

impressions. Individual ridge characteristics may vary slightly in actual shape or physical position due to twisting, pressure, incomplete inking, condition of latent print when developed, powder adhering to the background etc., but identification is based on a number of characteristics viewed in unit relationship and not on the microscopic appearance of individual characteristics. (The Science of Fingerprints – FBI, 1977 Edition, Page – 194).

The shape of certain ridge characteristics plays a less important role to their positions in relation to one another. Bifurcations, ridge endings and enclosures may not be the same in appearance in different prints of the same digit. (Soderman, Modern Criminal Investigation, 1962 Edition, Page – 139).

Variations in pressure as well as lack of uniformity in inking may introduce discrepancies in the breadth of a ridge or in the appearance of a ridge detail. (Cummins and Middlo, Fingerprints, Palms and Soles, 1961 Edition, Pages – 29 & 30).

Apparent variations also known as superficial dis-similarities are always possible in two impression of the same finger more so, when one of them is a chance print developed from the scene of crime/ crime article or is an impression on a document not properly recorded, and the other, a carefully recorded print by a professional for the purpose of comparison. These variations are bound to appear magnified in the photographic enlargements supplied along with the reports. The application of a developing powder with a brush to a latent print can cause certain difference especially in the general appearance of ridge characteristics as well as thickness of ridges.

While developing a latent print with powder and brush, certain minor but unpreventable changes do occur in the print. A small gap between two ridges may be filled by the powder which may thus appear as a continuous ridge. Other similar modifications result in the powdering process but are usually of little importance. (Bridges – Practical Fingerprinting, 1963 Edition, Page – 149).

Scene of crime prints often accentuate superficial dis-similarities. But whatever variations occur in the general appearance of a mark, the sequence of ridge characteristics always remains constant. No doubt can be cast upon the identity of two prints by dwelling on such extraneous differences. (Cherril, The Fingerprint system at Scotland Yard, 1954 Edition, Page – 262).

Theoretically even on dis-similarity and not an apparent one. A real dis-similarity means, a clearly defined ridge characteristic present in one print is Non-Existent in the other, in its corresponding location and relative position with other ridge characteristics. It is only such a dis- similarity which cannot be reconciled, explained or accounted for, that will help to prove the non- identity of two prints. And this is what is claimed by the profession, as not come to the notice so far, in two identical prints. (Andre Moenssons, Fingerprint Techniques, 1971 Edition, Page – 262).

It will not only be farther from truth, but will amount to professional misconduct, if anyone were to suggest even by way of argument that one dis-similarity would result in the conclusion that two fingerprints are not identical, notwithstanding they contain sufficient identical ridge characteristics. (Parduman Singh, Scene of crime prints in police investigation, 1978 Edition, Page 112).

Conclusion

Two fingerprints are identical and are produced by the same finger of the same person if they both contain sufficient number of matching, ridge characteristics in their relative positions, even if they exhibit dis-similarities which can be reconciled, explained or accounted for, by a competent expert giving an honest opinion.

2.17 LAW RELATING TO FINGERPRINTS

The application of fingerprints in the identification of persons does not violate the fundamental rights under article 20(3) of the constitution (A.I.R. 1961 S.C 1808). The law states „No person accused of a crime shall be compelled to be a witness against him.

- Section 45 Indian Evidence Act

When the court has to form an opinion upon a point of foreign law, arts, science, etc including finger impressions, the opinion of persons specially skilled in such foreign law, arts, science, etc including finger impression are relevant facts. Such persons are called experts.

- Identification of Prisoners Act

Section 3 provide for taking fingerprints of a person convicted in connection with a crime punishable with one year (R.I) or which entitles him for enhanced punishment on subsequent conviction or bound down for a period of one year or more.

- Identification of Prisoners Act

Section 4 provide for taking fingerprints of a person arrested in connection with a crime punishable with one year R.I or which entitles him for enhanced punishment on subsequent conviction or bound down for a period of one year or more.

- Identification of Prisoners Act

Section 5 read with section 73 of the Indian Evidence Act provides for taking specimen fingerprints of any person for comparison with any other prints alleged to have been made by such person.

- Section 73 Indian Evidence Act

The court may direct any person present in the court to give his/her finger impressions to enable the court to compare such finger impressions with any other finger impressions alleged to have been made by such person.

- Section 293 Cr. PC

Section 293 Cr. PC exempts Directors of Fingerprint Bureaus from personal appearance in the Courts for expert testimony.

- Section 155 Indian Evidence Act

The evidence of an expert can be impeached only in the manner provided in section 155 of the Indian Evidence Act and not otherwise.

- Section 159 Indian Evidence Act

While giving testimony an expert may refresh his memory by reference to professional treatises or personal notes

- A.I.R-1972, S.C. 975

The reason why the report of the Director, Fingerprint Bureau is treated as evidence without examining him is that the comparison and identification of fingerprints has now developed into a science and the results derived there from have reached a stage of exactitude. (A.I.R. 1972 S.C. 975).

- As long as the report shows that the opinion was based on observation, which led to a conclusion, that opinion can be accepted. (A.I.R 1972 S.C. 975).
- A.I.R. 1978, S.C. 1220 & Criminal Law Journal 1978 M.P 1220

Where it is proved by competent expert testimony that two fingerprints contain several points of agreement and no points of disagreement in minutiae, no further evidence is necessary to prove that they were made by the same finger (Criminal law journal 1978 M.P 1220).

- The reasons given by the expert in arriving at the conclusion are ultimately to be weighed by the court and satisfy itself about the correctness of the conclusion by comparison of the prints. if the photographic enlargements are kept side by side and their marking compared, it becomes much easier to follow the reasoning of the expert about the points of similarities or dissimilarities and thus judge the correctness of his conclusions (Criminal law journal 1978 M.P 1220).
- A majority of fingerprints found at the scene of crime or on crime articles are partially smudged and it is for a skilled and experienced fingerprint expert to say whether a mark is useable as finger print evidence. Similarly it is for a competent technician to examine and give his opinion whether the identity can be established and if so whether that can be done on eight or even less identical ridge characteristics in an appropriate case. (A.I.R 1978, S.C 1183).
- A.I.R – 1979, S.C. 1708

Science of fingerprint identification is an exact science and does not admit of any mistake or doubt. (A.I.R. 1979, S.C. 1708).

UNIT II-B-TRACK MARKS

2.18 FOOT PRINTS

A large percentage of people still walk barefoot in the country and almost so inside the homes. The criminal perhaps finds it convenient to operate barefoot as it gives him a better hold to climb or slide, walk or run and also it does not make any sound, which might draw the attention of people during his operations.

The human foot is unique in its structure and is therefore readily distinguishable from the foot of other animals. There are 28 bones in the human foot of which seven are tarsal bones; five are metatarsals, fourteen phalanges and two small bean size sesamoid bones. The two sesamoid bones are located below the head of the first metatarsal bone. The heel bone (calcaneum) and other tarsal bones bear most of the body weight while the metatarsal bones and the phalanges articulate with the tarsal bones in the process of locomotion. The bones and other soft tissues like ligaments, muscles, padding material and skin on an applied pressure of the body produce a foot print that is proportional to the build and other characteristics of the foot.

The shapes of foot impressions differ from individual to individual.

Broadly the shapes can be categorized into:

(i) Normal type foot

(ii) Club shaped foot

(iii) Bow type foot

(iv) Flat foot

(v) Broken bridge type foot and

(vi) Accidental foot or Abnormal foot

SKEMATIC DIAGRAM SHOWING VARIOUS PARTS OF A FOOT PRINT

(KOJI SYSTEM)

2.18.1 CLASSIFICATION OF FOOTPRINTS

Depending on the surface on which the prints are made, footprints can be classified into

i) Surface foot prints

ii) Sunken foot prints

Surface foot prints: Surface foot prints are formed on hard surfaces like cement/stone floorings, tables, chairs, walls, etc. They are formed when the surface of the foot is coated with dust, dirt, oil, ink, blood, etc. Surface prints do not undergo any distortion and they register the distinguishing characteristics of the foot better than sunken prints. Surface prints have two dimensions, viz., length and breadth.

Sunken foot Prints: Sunken foot prints are those that are found on pliable surfaces like soft clay, mud, loose soil, etc. Slightly sunken prints are usually formed on a small

quantity of accumulated mud or soil on hard surfaces, e.g. a verandah. Moderately sunken prints are formed on slightly loose soils and deeply sunken prints are formed on mud, wet loose soils, clay, etc. The less sunken footprints offer a more definite clue for comparison than moderately sunken or deeply sunken footprints. The sunken footprints have an extra dimension in addition to surface print, i.e.; the depth (or height).

2.18.2 LOCATION OF FOOTPRINTS

1. *At the scene of crime:* The scene of crime is often a good source for the location of footprints as this is where the criminal primarily operates. The place should be properly searched for footprints from the focal point of the crime scene. Focal point in a murder case is the dead body at the scene of crime, and in a burglary the almirah, cash chest or cupboard from where the cash, jewelry or other valuables have been stolen. The search may be extended to the entire crime scene, from the focal point.
2. *Along the route:* The route taken by the criminal both at the time of entry and exit should be thoroughly searched for his footprints. Entrance points like doors, windows, ventilators, and roofs could contain the footprints of the criminal, which should be properly collected.
3. Sometimes the criminals may assemble together at some secluded place near the scene of crime to plan before the crime or to share the booty after the crime. Such assembly sites if identified after the reconstruction of the crime should be searched for footprints.

2.18.3 COLLECTION OF FOOTPRINTS

The methods commonly used for collecting footprints are:

1. *By preserving the original impression intact:* If the foot print is found on a portable object such as a mat, slab, plank, card board, etc. it is convenient to carry the object bearing the print to the laboratory for photography and further analysis. It is advisable to take the photograph of the print even in such cases before removing them, as there is always the risk of the original impression being damaged in packing or transit.
2. *Photography:* All foot prints, whether sunken or surface or any other track marks should first be photographed by keeping the lens of the camera parallel to the surface on which the marks or impression is found. The aperture of the diaphragm should be adjusted to get a proper depth of field. At least three photographs are to be taken, one direct view from the top and the other two from either side at an angle of 45 .Before taking the photograph place an identification slip or card (containing crime number, section of law, date, police station, district etc. with initials of the IO) close to one side of the print and a foot rule on the other side to record the actual size of the footprint.

3. *Tracing:* Tracing is a rough method to record surface prints. A glass (or preferably a celluloid sheet) is held over the print as close as possible. Care should be taken to ensure that it does not come in contact with the print. Then a sketch pen draws the contours along the print line. Details such as the characters of the toes, ball of the foot, instep and heel together with crease; cracks, warts, etc. should carefully be traced on the sheet. After the tracing is complete the sheet is removed and all the particulars of the case should be

written on the glass together with the signature of the investigating officer and the witnesses. On the basis of such prints on glass any number of tracings can be obtained on tracing paper. The glass sheet and a tracing paper should be packed in between two cardboards for transport to the court. The value of traced print depends upon the personal observation skills of the person who is tracing the print and therefore is highly subjective and not very reliable. Other methods of recording like lifting and casting are preferred to tracing.

4. *Lifting:* When the print is formed on a surface that is of a similar colour to the print, for instance, a blood stained print formed on a red surface, dusty (white) print formed on a white surface, dark (black) print formed on a black surface, it becomes difficult to photograph the print because of the similar colour of the background. In such conditions the print could be collected using an appropriate photographic paper, like black photo bromide paper for a dusty or light coloured print and white photobromide paper for a blood stained or black print. This black or white photobromide paper can be obtained by exposing the photo sensitive paper to light before development to get black paper and directly developing it to obtain white bromide paper.

The processed paper so obtained should be moistened for few minutes in water, preferably with a few drops of ammonia added. When all the excess water is removed it is placed over the print with the emulsion side of the paper in contact with the print and beaten firmly with a cloth taking care to prevent slipping or sliding of the paper over the print. The paper is lifted after few minutes and allowed to dry. The foot print particles get attached to the surface of the photo bromide paper forming a clear and visible print. The side should write particulars of the case with signature of IO and witnesses without disturbing the print.

Footprints can also be lifted using photographic film or transparent adhesive tape. The fixed photographic film is moistened in water for few minutes until the emulsion side becomes tacky and then placed over the print with the sensitive side in contact with the print. A uniform pressure is applied over the film for few seconds and it is then lifted carefully. The print is transferred on to the film, which can then be used as a negative to make copies from.

5. *Casting:* Casts are prepared from foot impressions (sunken foot prints), tyre impressions or other impressions left behind by the criminal. A variety of materials are used to prepare the cast, e.g., plaster of paris, wax, resins, plastic powders, modelling clay, sulphur, lead, wood metal, plasticine, moulage material, silicone, etc. However plaster of paris is most commonly used. Carefully remove extraneous matter (grass, twigs, stone, etc.) from the impression without disturbing it. Place a metallic or a wooden frame around the impression to prevent wastage of plaster of paris. Do not apply pressure on the frame as it will damage the print. Spray shellac solution (about 250gm of shellac dissolved in one litre of alcohol or a thinner solution) from a distance over the impression. Spray enough solution to get a thin film of shellac over the impression and allow the shellac to dry for 10-15 minutes. A thin layer of talcum powder is sprinkled on the layer of shellac to separate the

shellac from the cast. Mineral oil or sewing machine oil is also employed for this purpose. Take a container with 3 mugs of water and slowly pour 3 mugs of plaster of paris into the water. Gently mix till it reaches a thick creamy consistency. The water and plaster of paris are taken in a 1:1 ratio. Pour the solution into the impression at an unimportant place e.g. a corner of the frame to avoid damage to the impression due to pouring. It should be allowed to flow slowly till it fills the impression to a uniform thickness of about 1/2 an inch. Reinforce the cast at this stage with wire gauze pieces and pour the remaining solution till it acquires a thickness of about one inch. The cast is allowed to set for 10-15 minutes. With the copying pencil engrave the following details have to be written on the cast itself:

a) Crime number, Section of law and Police Station.

b) Exact location.

c) Date and time of recording.

d) By whom recorded.

e) Signature of IO

f) Signature of witnesses.

A sample of the plaster of paris and soil should be preserved for obtaining test prints of the suspect under similar conditions. Remove the retaining walls (wooden frame) by digging away the surrounding earth and gently slip your fingers under the cast to lift it very carefully. Pour water over it to remove any adhering earth particles. Care should be taken not to brush it to prevent obliteration of the details of the footprint.

2.18.4 MODERN METHODS OF COLLECTION

Electrostatic technique: The dust particles adhering to the foot or foot wear that form a dusty print on the floor can be lifted by the electrostatic technique. A black vinyl sheet is placed over the suspected area containing the foot / foot wear print and it is covered with aluminium foil through which a high voltage of current (1500 volts) is passed. The dust particles that form the foot print are attracted towards the vinyl sheet and become attached to it and can be photographed for a permanent record.

Holography (laser technique): This technique was developed by Dr. Bradford, a British scientist and involves the use of laser beams to locate the foot prints or shoe prints on the floor carpet. When a person walks on a carpet, the fibers of the carpet are compressed on account of the pressure exerted by the weight of the person and a contour of foot or foot wear is left on the carpet. With laser beams it is possible to record such compressed marks on a photographic plate. This technique is known as holography and such a photograph is known as a hologram.

2.18.5 COLLECTION OF TEST PRINTS FOR COMPARISON

The crime scene foot prints have to be compared with the test print obtained under similar conditions from the suspect/ accused. e.g., if the surface crime print is made with a liquid medium, the test print must also be made with a liquid medium for comparison. If the surface crime print is in human blood the test print should be caused with goat or fowl blood. To get the complete picture of the sole it is worthwhile to obtain prints in

different positions i.e., in normal standing position, with pressures on inner and outer side, when walking, running etc.

2.18.5 PRECAUTIONS IN COLLECTION OF FOOT PRINTS AND FOOTWEAR PRINTS

1. If the footprints are on easily removable articles, they should be packed & forwarded.
2. IF the prints cannot be immediately removed or recorded they should be covered with inverted hollow cardboard boxes or any other suitable objects.
3. If footprints are in open places, adequate precautions should be taken for protection.
4. All prints and impressions should be photographed before attempting any other method.
5. While taking photographs:
    a) The lens of the camera should be kept parallel to the surface on which the print is found.
    b) A scale or foot rule is to be kept along the length of the footprint.
    c) A paper containing identification details such as date, crime number police station, location, left/right foot print etc., should be kept besides the footprint.
6. In case of tracing of footprints:

    The sheet of glass or celluloid should not actually touch the impression.

    a) The sheet should not be moved until the tracing is complete.
    b) The lines should be drawn as thin as possible.
    c) The part of the foot for which the tracing is to be made, the tip of the pen and the eye should be in a line vertically above the print.

The clear edge of the different parts of the footprint should be shown in thin continuous lines. The faint and doubtful impressions may be shown with dotted lines.

2.19 FOOTWEAR MARKS

Footwear evidence is important track evidence because of the infinite variety of footwear and their wear and tear patterns. Footwear evidence can be utilized to identify the foot of the wearer and the places he is likely to have been present.

A footwear print is caused when the sole of the foot - wear is coated with dust, soil or liquids like blood, soil etc. Foot-wear impressions can also be seen on loose soil, mud, clay etc. The print not only gives the dimensions and designs of the sole but also the wear and tear patterns. Presence of nails or missing nails, stitches, patches and their size and shape, all of which offer individual characteristics of the sole.

Presence of extraneous material on the shoe sole like dust, mud, oil, blood etc., also is useful in tracing a person to a particular location viz., crime scene. If a footwear is recovered from the scene of crime it is possible to identify the footwear from its various characteristics including the status of the wearer, material used for manufacture, craftsmanship, wear and tear pattern and repairs. The size and condition of the foot wear

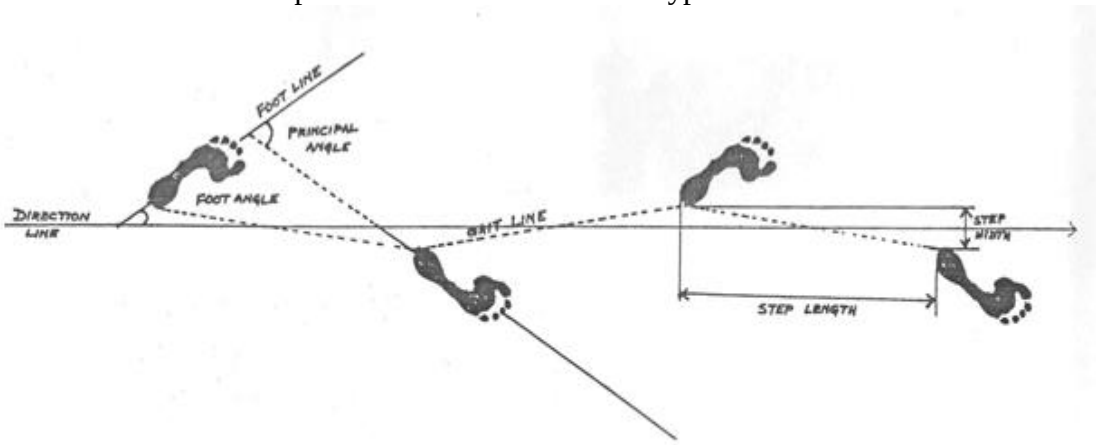
can also reveal the height, health of the person, his financial status, his habit of sanitation and cleanliness, deformities in the legs etc. These clues help in identifying the persons present at the crime scene.

2.20 HOOF MARKS & PAW MARKS

Individualism of hoof marks is difficult. Often the nature of the animal alone can be given. Sometime damage to the hoof or wear and tear of the iron-shoes of a shod animal may permit individual identification of the animal.

The paw marks sometimes contain crease and crack marks. They permit positive identification if the animal or its specimen marks are available.

The nature of the marks permits identification of the type of animal.



GAIT PATTERN (WALKING PICTURE)

2.21 GAIT PATTERN (WALKING PICTURE)

Gait Pattern or the walking picture is the trial of foot prints or foot wear prints left by the criminal in and around the scene of crime. In ancient India people from rural areas (mostly around Rajasthan) developed an art of tracking trails of camels and other animals. These people are known as *Khojis (Khoj* in Hindi is search), and often their services were utilized to track the criminals. Although these *Khojis* were uneducated they could recognize the various characteristics of the foot print and the walking style of a person. The gait pattern was studied systematically by considering at least four consecutive steps of the walker as shown in figure to establish the characteristics of the gait pattern, as discussed below.

The direction line:- It is an imaginary line along the center of the path followed by the person. It shows the direction in which the person has walked or moved.

The gait line:- The gait line is obtained by joining the heel marks. It coincides with the direction line and may be irregular, zig-zag or broken depending upon the type of walking. Drunkards or persons carrying a weight may produce broken gait line.

The foot line:- It is the central line of the foot (or foot wear) joining the direction line. It passes through the center of the foot, in longitudinal direction.

The foot angle:- It is the angle made between the foot line and the direction line. The foot angle is highly characteristic of an individual and varies from person to person and also sometimes from the left foot to the right foot of the same individual. Males have a wider foot angle than females. Normal foot angle is 30 to 32 degrees but is highly variable in different individuals. The foot angle is greater for persons carrying weight or for pregnant women.

The principal angle:- It is the angle made between the two consecutive left and right foot lines and is equal to the sum of two foot angles.

The step length:- The distance between the centers of two consecutive heel marks is the step length and is suggestive of a person's walking style viz. slow walking, fast walking, running and varies from 20 to 40 inches. For slow walking 271nches is the average, for fast walking 35 inches is the average and above 40 inches for running. The step length is proportional to the height of a person. Tall persons have a longer step length than shorter persons. But when a person is suffering from hernia or pelvic disorders he may register a shorter step length. Males show longer step length than females.

The step width:- Step width is the distance between the two feet drawn along the direction line touching the inner border of the foot. Step widths vary with the weight, deformality etc.

In addition the other characteristics noted are the general shape of foot print, dimensions of the toe marks, ball of the foot, instep, heel marks, crease marks, phalange marks, cut marks, peculiarities in the marks, pressure points and twists of the foot.

2.22 TYRE IMPRESSIONS

The modern criminal finds the automobile as an indispensable part of his equipment, in the commission of crime, disposal of dead bodies and for other criminal activities. Tyre impressions left at the scene of a crime may at times form the only clue to the perpetrator.

In unusual circumstances, a characteristic feature of a tyre such as an inserted patch, or a peculiar injury to the tyre may be noted. In such cases identification may often be made with a very high degree of certainty.

2.22.1 TREAD CHARACTERISTICS

1) The overall design or pattern of the ridges.
2) The dimensions, e.g. distances between the ridges, angles, or other prominent features.
3) The relation and positioning of similar ridges with respect to each other.
4) Unusual features, whether originally present in the tread or put there as a result of repair, wear or accident.
5) Extent and nature of wear.

A known tyre track is compared with a questioned tyre track, rather than comparing the latter directly with the tyre.

2.22.2 DIRECTION OF TRAVEL

By examining the tyre track it may be possible to determine the direction of travel. If a car is traveling forward in a straight line only the impressions of the rear tyres will be visible. If the car has reversed, then only the impressions may be visible. If it has taken a turn, all four tyre impressions may be visible. On asphalt or other hard surfaces oil drops may indicate the direction in which the car was traveling. The drops taper towards the direction of travel.

2.22.3 RECORDING TYRE IMPRESSIONS

Plaster casts are the accepted medium for the reproduction of tyre marks. The procedure for making a plaster cast and the principle of comparison is the same as in the case of shoeprints. Photographs should be taken prior to lifting. It must be ensured that impression of a tyre's entire circumference is obtained to achieve more definite

Nature of Examination Conducted on Tyre Impressions.	**Type of Analytical information FSL can provide.**
a. Dimensions	Whether the crime print was made by the suspected tyre or not.
b. Design	
c. Tread Pattern	
d. Wear & Tear	
e. Distance between ridges & angles	
f. Other peculiarities	

comparison.

2.23 SKID MARKS

When the brakes of a speeding car are applied suddenly, the friction between the tyre and road heats the rubber, depositing a thin layer of rubber particles. This is noticeable as black mark in the path of the tyre. This mark is called skid-mark.

In a motor vehicle accident the investigator has often to determine whether the cause of accident is due to deficiencies in the brakes or due to rash and negligent driving. Usually the only evidence present is a set of skid marks. These marks may be shown to be a measure of the probable stopping distance, i.e., the distance traveled by the vehicle from the moment of full application of brakes to the moment the vehicle comes to a stop.

The length of the skid marks depends upon the speed of the vehicle, is total weight, and the condition of its tyres and the nature of the road surface. For the calculation of the speed, a test skid mark is created at a reasonable known speed on same or similar road

and with the same vehicle if available. Having measured the length of the skid mark produced at the scene, and the length of the test skid mark at known speed, the speed of the vehicle at the time of meeting with an accident can be determined by the following formula:

$$V1 = V2 \frac{S1}{S2}$$

Where V1, S1 refer to the speed and skid length relating to the accident and V2, S2 refer to the speed and skid length of the test driven vehicle respectively.

GLOSSARY:

1. Arch
2. Fluorescence.
3. Iodine fuming.
4. Latent fingerprint.
5. Loop.
6. Ninhydrin.
7. Superglue fuming.
8. Visible print.
9. Whorl
10. Gait.
11. Casting.
12. Footprint.

LEARNING OUTCOME:

After studying this unit you should be able to:

1. Perform the procedures to develop and lift fingerprints from different surfaces.
2. Understand different ridge patterns.
3. Classification of footprints.

SUGGESTED READINGS:

1. Fingerprints, Analysis and Understanding – Mark. R. Hawthorne.
2. Advances in Fingerprint Technology – Henry. C. Lee and R. E. Gaensslen.
3. Forensic Fingerprints – Max. M. Houck.
4. Fundamentals of Fingerprint Analysis – Hillary Moses Daluz.
5. History of Fingerprinting and Criminal Identification – Simon. A. Cole.
6. Friction Ridge Skin, Comparison and Identification of Fingerprints – James. F. Cowger.

UNIT III

LEARNING OBJECTIVES:

In this unit you will be introduced to:

1. The term Questioned Document.
2. The common individual characteristics are associated with handwriting.
3. Some important guidelines for the collection of known writings for comparison to questioned documents.
4. Recognition of some of the class and individual characteristics of printers and photocopies.
5. The techniques document examiners use to uncover alterations, erasures, obliterations, and variations in pen inks.

UNIT III- Questioned Documents

3.0 INTRODUCTION

The increasing use of documents of many kinds is one of the hallmarks of the modern civilization and with the opportunity for fraud that they offer and with human nature not yet controlled by any universal force, the scope for documentary frauds is phenomenally growing.
Questioned Document Examination (QDE) is the Forensic Science discipline pertaining to documents that are (or may be) in dispute in a court of law. The primary purpose of questioned / forensic document examination is to answer questions about a disputed document using a variety of scientific processes and methods.
The credit of rising the status of the document examiner goes to the American Author ALBERT OSBORN who was the FATHER OF QUESTIONED DOCUMENTS
published (1) Questioned Documents, (1910); (2) Questioned Documents Problems, (3) The Problem of Proof (1922). These books are regarded as classic books in the field. He is the person who has proved that: "HANDWRITING IDENTIFICATION IS SCIENTIFIC."

After Osborn, significant contribution in this field is made by WILSON HARRISON by his publications: (1) Suspect Documents, (2) Forgery Detection. Document Examination in India was started as early as the year 1903 and with the advancement of science and technology, the science of Document Examination also progressed rapidly.

Another expert who made valuable contribution to document examination was Mr. **CHARLESS HARDLESS**, an Accountant in the office of the Accountant General, Calcutta, and the then capital of British India. He has initiated his own principles of scientific examination of Handwriting Identification and Detection of forgery and assisted many courts, police and Government Offices through his opinion on Handwriting Identification in 1903 even before the famous book "Questioned Documents" written by "A.S. Osborn" came into existence. For many years, he was the questioned document examiner to the Government of India. He published in 1912 a book with the title **THE IDENTIFICATION OF HANDWRITING AND THE DETECTION OF FORGERY**. In 1906, a post of Handwriting Expert for the Government of India was created and Mr. Hardless was appointed to this post under the Director, Criminal Intelligence Department at Simla. He was replaced by

Mr. F. Brewester, a police officer from West Bengal CID, who was designated as **GOVERNMENT EXAMINAER OF QUESTIONED DOCUMENTS**.

A book entitled „Contested Documents and Forgeries in India was published in 1932 by F.BREWESTER, who for many years was the Government Handwriting Expert of India. Mr. Brewester was a student of Osborn and the Chapter on Ink in Questioned Documents in his ‘Questioned Documents’ was written by Mr. Brewester.

In 1919 M/s. **HARDLESS AND HARDLESS** published a book entitled **FAULTS AND FALLACIES IN HANDWRITING IDENTIFICATION AND EXPERT EVIDENCE IN INDIA**. In India three **GOVERNMENT EXAMINER OF QUESTIONED DOCUMENTS**, i.e. **GEQD’s** were established the first one at Shimla (1906), then at Calcutta (1964) and followed by Hyderabad (1968). With the recommendations of the Central Government, all State Governments have started State

Forensic Science Laboratories in India after 1950, and some of them have also established Regional & District Forensic Science Laboratories.

Though Forensic Science alone does not provide all answers to crime and its connected problems, it has a vital role to play as supportive service to the police investigator, provided he has the requisite inclination and orientation to seek the help of the scientists.

3.1 SCOPE OF DOCUMENT EXAMINATION

A forensic document examiner is intimately linked to the legal system as a forensic scientist. Forensic science is the application of science to address issues under consideration in the legal system.

A forensic document examiner deals with material items (physical evidence) that form part of a case which may or may not come before a court of law.

Many examinations involve a comparison of the questioned document, or components of the document, to a set of known standards. The most common type of examination involves handwriting wherein the examiner tries to establish proof about potential authorship.

One of the most important aspects in the examination of questioned documents is Handwriting Analysis. Broadly, it may be considered as a science of comparison.
Any surface containing handwritten, typewritten, machine printed markings or inscriptions made by men or machines whose source of authenticity is disputed, suspected or questioned is a „QUESTIONED DOCUMENT‰. It includes writings on walls, doors, carriages, etc. The handwriting expert compares the admitted standard writings and signatures of a person(s) with those on disputed documents and gives his opinion on the authorship of the disputed writings and signatures. The expert also examines the Questioned documents using microscopic instruments under visible, ultraviolet and infrared light and offers his opinion regarding the alterations, additions, interpolations, erasures, obliterations, secret writings, and indented writings, found on such documents as bank cheques, receipts, pronotes or any other questioned documents. Expert opinion is also given on typewriting, stamp impressions, printed matter, paper, ink etc.

A document examiner is often asked to determine if a questioned item originated from the same source as the known item(s), and then present his opinion on the matter in court as an expert witness. Other common tasks include determining what has happened to a document, determining when a document was produced, or deciphering information on the document that has been obscured, obliterated or erased.

3.2 DIFFERENT TYPES OF CASES

Involving different types of questioned documents are:

i. Misappropriation, cheating.
ii. Murder cases.
iii. Educational frauds.
iv. Departmental frauds.

v. Bank Frauds.
vi. Co-Operative Society frauds.
vii. Postal & Insurance frauds.
viii. Chit Fund frauds.
ix. Cases of scams & leakages.
x. Lock-up death cases.
xi. Dowry death cases.
xii. Lottery Tickets
xiii. Anonymous petitions.
xiv. Civil disputes:
- Promissory notes,
- Sale deeds,
- Lease deeds,
- Mortgage deeds, etc.

3.3 DIFFERENT TYPES OF QUESTIONED DOCUMENTS

EXAMINATIONS OF QUESTIONED DOCUMENTS INCLUDE THE FOLLOWING:

1. Writings / signatures / initials
2. Alterations / Additions / Insertions
3. Erasures / Obliterations
4. Invisible writings
5. Indented writings
6. Stamp / Seal impressions
7. Type writing / cyclostyle copies / printed matter
8. Paper
9. Ink
10. Torn documents
11. Charred documents
12. Photostat / Fax / Carbon copies.

Each category of evidence requires different methods of analysis.

3.4 EXAMINATION OF WRITINGS / SIGNATURES / INITIALS

One of the major problems encountered in an inquiry regarding a document, is the genuineness or otherwise of the writing / signature / initial, but every document which requires examination should be scrutinized in every possible manner that may possibly throw any light upon its origin, its age, or its quality, or condition that may have a bearing upon its genuineness.

Definition:
Document: Any material that contains marks, signs or symbols, either visible, partially visible or invisible that may ultimately convey a meaning or message to someone is called a '***DOCUMENT***'.

Questioned / Disputed Document: All documents are not disputed documents. When the genuineness of the document, or, the contents or facts related to its production arouses

suspicion, such document will termed as „Questioned / Disputed Document‰.

Handwritings: Visual expressions in the form of signs or marks made by a person by coordinated effort of brain, nerves and muscles, useful as a means of communication.

Signature: Signature is an expression in the form of writing but with limited number of characters - highly individualized due to regular practice and use and represents an individual.

Initial: Short form of signature

Handwriting which may be defined according to C.A.MITCHELL, „An expression of thoughts by means of visible symbols, has evolved out of primitive attempts to represent external objects by conventional pictures of hieroglyphics‰ and in case of signature, WEBSTER says, A signature as one's name written by himself on a document as a sign of acknowledgement.

Whereas JAMES V.P.CONWAY says, an evidential signature is not simply a signature, it is a signature signed at a particular time and place under particular conditions, while the signer was at particular age, in particular physical and mental conditions using particular implements and with a particular reason and purpose for recording his name.

The surface that qualifies for a document in this contest is not only a paper, but also it can be:

Wall, Stone, Wood, Leather, Plant Leaf, Trees, Cloth, Glass, Magnetic Tape or even the Skin of the Body parts, like Hands and Legs.

For the purpose of examination of disputed writings / signatures / initials, either to fix the authorship or to detect the forgery, the comparison material i.e. standards are required.

3.4.1 STANDARDS FOR COMPARISON

Standards are those writings which are written by a suspect especially for the purpose of comparison or written by him/her in his/her routine transactions. The first category is called specimen standards and the second category is admitted standards.

Since the scientific method of identification of a disputed writing or signature is based on its comparison with the known genuine writings or signatures of the alleged writer, the suitability and adequacy of standards for comparison are of primary importance. The standards must be in accordance with the basic rule of comparison. „Like be compared with like‰. Both the questioned and the standards must be of the same script and class (surface and instrument etc.) and contemporary (near about date/month/year) to the questioned / disputed documents.

The basic requirement of the standard writings and signatures is that these must contain a sufficient amount of material to indicate the identifying writing habits, their qualities and the range of natural variations in the writings of an individual, i.e. the standards must give a full picture or should be indicative of the writers writing habits during the

period, or as near thereto, as possible when the questioned writings were written or supposed to have been written.

STANDARD WRITINGS classified and defined as:

- Admitted
- Specimen

Admitted writings mean writings which are written by a person in his/her normal routine course of activity / business, which are freely written, natural and undistorted. As while writing such writing, a person is not aware that these will be or may be later on used for the purpose of comparison with questioned writings, and as such these writings are supposed to portray normal writing habits of a writer.

The Available Forms for Admitted Writings / Signatures:

The material for comparison of handwritings, signatures and initials may be available in any of the following sources written by a suspect (/victim) in his/her normal course of business. The list below is indicative but not exhaustive or all inclusive.

1. DOCUMENTARY EVIDENCE FROM BANKS/CO-OPERATIVE SOCIETIES: Cheques, withdrawal forms, New account opening forms, fixed/recurring deposit forms, specimen signature cards, DDs, traveler's cheques, loan application forms, vouchers, credit slips, ledger books etc.
2. BUSINESS DOCUMENTS: Agreements, quotations, invoices, share certificates etc.
3. REVENUE DOCUMENTS: Revenue records, deeds, agreements, property certificates, Patta passbooks, income certificates etc.
4. PERSONAL DOCUMENTS: Post cards, inland letters, envelopes, diaries, applications for employment, birth certificates, death certificates, promissory notes, credit cards, I.D. cards, pass ports, caste certificates, income certificates, pass books, receipts, bus passes, leave letters etc.
5. ACADEMIC DOCUMENTS: Answer scripts, school/college applications, Memo of marks, certificates, bonafide certificates, Research theses, Project reports, notes, records etc.
6. SERVICE DOCUMENTS: Service Registers, G.Os, Salary certificates, Income tax documents, Insurance documents, acquittance rolls, Official correspondence, drafts, leave letters, applications for loans such as P.F., LIC, Housing etc, Surveys, Sentry books, case diaries, Attendance Register, DoctorÊs prescriptions, Lawyer Diaries, Case sheets, Engineers Estimates, Project reports, Manuscripts, Petitions etc.
7. JUDICIAL DOCUMENTS: Affidavits, vakalatnamas, written statements, plaints, bail bonds, judgments, summons, warrants, depositions etc.
8. POSTAL DOCUMENTS: Passbooks, withdrawal firms, money orders, acknowledgements, envelopes, receipts etc.
9. CIVIL SUPPLIES: Waybills, receipts, ration cards etc.

10. MISCELLANEOUS DOCUMENTS: Lodge registers, lottery tickets, railway reservation forms, telegraph forms, suicidal notes, anonymous letters etc.

Specimen writings are the writings specially written by the suspect for the purpose of comparison with the disputed documents. This is usually done either in the open court

or in the presence of presiding officer. The following are the various steps suggested while procuring the specimen standards for making examination meaningful, objective and conclusive and also to ward off disguise.

(i) The suspect should be made to sit in a comfortable posture.

(ii) He /She should be supplied similar paper and writing instruments as that of the questioned.

(iii) The suspect should not be shown the questioned document.

(iv) Dictation should be given to the suspect at different intervals.

(v) After each dictation, the sheet of specimens should be removed, and a fresh sheet of paper to be supplied.

(vi) The dictated text should contain many of the words, phrases, numerals and letter combinations as found in the questioned document. No instructions should be given regarding spelling, grammar, punctuation marks etc.

(vii) At least 5-10 specimens should be taken. In case of deliberate efforts to disguise, more specimens should be taken.

(viii) As far as possible signatures and writings should be obtained in the natural 'setting' and 'medium'.

(ix) Each and every specimen sheet should be attested by the Investigating Officer along with the signatures of the witness appended on them with date.

(x) In case of specimen writings also the Investigating Officer should make all efforts to the expert to compare **LIKE WITH LIKE** with sufficient material.

After procuring the admitted and specimen writings, the Investigating Officer / forwarding authority should check:

(a) Whether there is sufficient material to reveal the individual characteristics as well as normal or natural variations.
(b) Whether all letter combinations and word combinations present in the suspected document included.
(c) Are the related dates/years of the questioned and admitted are proximate?
(d) Were the questioned and the specimen writings prepared under the same conditions? (same type of paper, instrument (pen, pencil) writing surface, position etc.).

Adequacy and suitability are in a way interdependent. One should not go by the mere number without regard to the various connected factors. The main criterion for adequacy is clear expression of individuality and habit. Further it is also dependent on the nature of the disputed, and nature and quality of the standards. That is why: the amount of writings / signatures necessary for comparison differs in different cases. The range of standard signatures extends so greatly only from the point of view of their nature and quality.

3.4.2 PURPOSE OF ANALYSIS/EXAMINATION

The purpose of analysis or examination of questioned writings / signatures / initials is: To identify whether a given questioned / disputed / suspected writing / signature / initial is written by the person suspected or not.

Comparison of hand writings / signatures / initials for purposes of identification is rather an extended process from observation to recognition of significance of similarities and differences. This process involves various mental activities i.e. observation, description, discrimination, interpretation. Observation implies analysis and proceeds with a purpose to recognize the identity or nonidentity of writing through significant similarities and differences in their characteristics.

Though Scientific Examination of handwriting involve a number of processes, of which comparison is the most important and final one, from which we make a judgment of identity or non-identity. There are certain stages and phases which go to systematize the examination and comparison.

The first stage is the examination of standard writings/signatures/initials by themselves (inter-se) without preference to or even before observing the disputed writing to recognize the individuality and habit, and to know the natural variation and also be able, on the one hand, to distinguish disguise if there be, and on the other, to eliminate wrong or forged or tampered standards if any or included in them.
The second stage is to examine the disputed/questioned writings/ signature/initial by itself without reference to the standards to find out whether it exhibits evidence of forgery or disguise or genuineness. If evidence of genuineness is found, then the further step is to recognize its individuality. If, on the other hand, any signs of disguise are found there is a need to see whether there is at all tangible individuality.
If there are more than one questioned writings/signatures/initials after examining each by itself, a comparison of all of them inter-se need be done. This is necessary to know (i) whether all or any of them are made by one person, (ii) whether they show natural variation or unnatural close resemblance, or (iii) whether all or any of them are exactly identical and superimpose one over the other.
Third and final stage is comparison of the questioned/disputed writings/ signatures/initials with the standard writings/signatures/initials for arriving at a final conclusion of identity or non-identity.

3.4.3 HANDWRITING PRINCIPLES

The correct identification of handwriting requires the evaluation of all the physical facts found in the writing not only in the light of the following basic rules but also with patience, common sense and intelligence. The identification of handwriting is based on some established scientific principles which are listed below:

(1) The handwriting of every mature writer is personal and individual to him alone.
(2) A person cannot produce in a mechanical manner exactly what has been written first. There must be certain natural variations in the writing of the same person.
(3) Related to the above principle, it is a fact that one cannot write two signatures precisely alike.
(4) If two signatures are precisely alike then one of them must be a forged signature.
(5) Every person's writing undergoes gradual changes in the course of life, however,

in most of the cases the changes are very slow and they may not be discernible.

(6) Two different persons cannot write in similar style.

(7) A writer cannot exceed his writing skill and ability unless he makes serious efforts and practice.

(8) A person cannot adopt different styles of writing at different times, as to change ones normal style of writing is an exceeding difficult task.

(9) An attempt to disguise leads to an inferior quality of writing and the disguise is always superficial. The writer, however, skilled he may be, can never be able to effectively disguise his writing in respect of all the characteristic features of writing.

(10) The attempted disguise in most of the cases is simple in nature.

(11) Handwriting does not exclusively depend upon the physical movement of hand or the writing instrument used.

(12) In spite of all the external factors such as nature of writing surface, writing instrument, position of the writer, nature of writing support, lighting conditions, influence of external conditions etc., it is a proved fact that "handwriting is 'brain writing' controlled by the signals sent by nervous system through hand".

3.4.4 BASIS OF HANDWRITING IDENTIFICATION – INDIVIDUALITY

Handwriting is an acquired art like other arts viz., painting, dancing or cycling. The early stages that accompany the learning and practicing of writing are characterized by a conscious effort on the part of a student to copy standard letter forms. He takes a mental impression of the model before him and makes an effort to translate it through muscles as writing. After practice, proficiency is acquired and the writing gets set and mature. It is then no longer effortful but almost a reflex action. A perfectly correct picture of the model is not grasped by the mind nor reproduced through the muscles. There are deviations in both these aspects. These mental and muscular deviations result in a nerve muscle reaction pattern and give the writing it's **INDIVIDUALITY**.

The various form variations in the writing are based on the mental conceptions which are employed and developed by the writer. The muscular movements are fashioned on the basis of those conceptions and by practice they develop into a habit. The varied forms and their details are the visible characteristics in the writing which form the basis of a scientific analysis. Thus we have four factors to consider: (1) The mental conceptions as the origin of individuality; (2) the movement pattern analogous to the conception; (3) the habit of which ensures the constancy of the movement pattern; and (4) the various characteristics as the reflectors of that individual movement pattern.

Each person has a distinct mental conception of style and manner of writing.

Characteristics, then, are the visible record, through which the expert can understand and get a complete and more coherent idea of the individuality and habit. A lay person identifies writings by their pictorial effect, stands for the individuality of writing. His concept of individuality is but the characteristic pictorial effect.

Pictorial effect is said to be the overall effect of the more obvious characteristics of handwritings, because a change in any of the obvious characteristics substantially alters

the pictorial effect. The natural process of integration which is a quality of the human mind and it forms a comprehensive concept of the individuality of the writing as a whole, is called Pictorial effect. In other words it is the cumulative significance of the observed characteristics.
The individual significance of characteristics, their mutual relation and their cumulative significance, all are simply felt by an ordinary man to form a judgment of identity. The expert, through scientific analysis and synthesis, makes explicit what is implicit in a lay person's process of identification. The felt judgment of an ordinary person which is considered for all purposes subjective is turned to a „reasoned judgment‰ quite objective in nature & verifiable by others.

VARIATIONS IN GENUINE HANDWRITINGS

It is a matter of common experience and observations that the genuine signatures and handwritings of an individual vary to an extent according to habit, circumstances and conditions under which they are written. Even if a person writes a number of signatures at the same time and in the same sitting, some **NATURAL VARIATIONS** must occur in the forms of letters and other features.
NATURAL VARIATIONS means normal or usual deviations found between repeated standards of any individual's handwritings. Variation is an inherent part of natural writing.
The human hand does not work like a mechanical device and the handwriting and signatures of the same individual show some variations due to the internal or external factors. But, it should be noted that such variations always occur within certain well defined limits in form, size, proportion, slant, etc. There may be divergences of varying degrees or of varying forms in the writing of different persons but the unmistakable distinctive feature of marked individuality cannot be found to have been spoiled by such variations.
The basic principle of handwriting comparison is that the handwriting habit of an individual once reached to maturity becomes a permanent and unconscious habit and the variations found in it are always superficial in nature.

The layman sometimes believes that the writing depends exclusively on the physical movement of hand or writing material used, which is obviously untrue.

In spite of so many external factors supposed to influence the character of handwriting, the consensus among forensic document examiners is that the handwriting is brain writing and that, for example, those who have lost an arm have reverted to the same characteristics with one hand as they showed with the other. Handwriting of an individual has so many peculiarities which make it most individualized and personal thing. The pen, it has been said is like a cutting needle which transforms the essence of music into the wax of master record, on the paper as on phonograph record, an under laying motive is reproduced. Both must be played back to reveal their hidden contents.

The peculiarities (Characteristics) in the handwriting as 'Osborn' says are of various degrees of force and value, ranging from permanent, habitual, occasional, and exceptional to accidental.
It is the specialist who is to judge the characteristics and ascertain their identifying value in a particular writing or signature (s). A characteristic in one writing may have an important bearing, while the same peculiarity may be of little significance in the other writing.

The presence of natural variations in writings and signatures is a strong indication of their genuineness. Once the two signatures are found to be having exact size and proportions, then one of them or both of them must be the forged signature(s).
The natural variations in the writings and signatures as referred above are always in the superficial features.

3.4.5 FACTORS AFFECTING THE HANDWRITINGS/CAUSES OF VARIATIONS

Handwriting is affected by unusual conditions in and surrounding the writer. The knowledge of the nature of the results produced by unusual conditions in the writing will serve two fold purpose; first, it enables us to exclude them in assessing the individuality, and second, they can be distinguished from the signs of disguise and of forgery.

i) Age

As time advances some of the old characteristics are modified or dropped and few new characteristics are acquired. The extent of change/variation depends upon the amount of writing done, the occupation, habits and environment of the writer. Old age may set in deterioration in strokes and poor forms of letters.

ii) Space

Restricted space mainly affects the size of letters, inter word and inter line spacing.

iii) Variations due to surface, writing instruments and support

The smoothness or roughness of paper may affect the line quality i.e. the quality of the edges of lines. Similarly some kinds of paper and ink may cause feathering of ink.

This may affect, in a way, the quality and pictorial appearance of the writing, but the writing all the same remains normal and its individuality is unaffected.

A difference in the nib used (i.e. in its width) may produce a difference in general appearance which is not material. A defective nib on the other hand obstructs the free and smooth travel and produces faulty strokes, scratches, and ink failures, a condition which is opposite in nature to the signs of forgery. Although freedom and flow are disturbed and the line quality is affected, the movement pattern and habit are not seriously disturbed however there may occur some superficial variations in the writings with different types of writing instruments which have little bearing on the process of writing comparison and the individuality would be clearly perceivable.

A firm support to the paper and hand enables the writer to maintain balance and consistent pen control. Unsteady or rough support to the paper would affect the line quality. An awkward or uncomfortable posture of a writer is also likely to cause a similar imbalance, but here the writer's reaction is to adapt to the condition and make the writing as normally as possible and the disturbance would be much less or negligible.

Moving condition i.e. the writing made in a moving train or bus or while walking too disturbs the balance.

iv) Variations due to weakness of sight

In the case of poor visibility neither the hand nor its nervous organization is disturbed but the sensory feedback process does not operate properly and so the writer does not have a clear picture of the formations as they are being written. Consequently he may overwrite or rewrite letters or parts of letters. The quality of writing may become inferior. But since the nervous organization is not affected, the formation, nor with standing the rewritings etc., would show the habitual movement pattern enabling to perceive the individuality.

v) Variations due to illness/psychology

It is a settled principle that once the nervous and/or muscular system involved in the production of handwriting weakness, the writing deteriorates.

Illness or old age or state of emotion and anxiety affects the nervous organization of the writing hand, in which case the results of nervousness like tremor are found in the writing. The nature of the results will depend on the nature of the affectation. Due to such effect, the writing becomes less coordinated, showing decline in the degree of skill, legibility and smoothness of strokes. The uncertainties and lack of uniformities being the common factors.

Some of the common effects of ageing and illness on hand writing are enumerated below:

1. Writing tends to be of inferior quality.
2. Difficulty in starting the lines.
3. Strokes may be irregular and shaky.
4. Lack of uniformity, and decline in the writing skill and legibility.
5. Uncontrolled impulses within the signature.
6. Sometimes parts of letters, full letters or even parts of names are omitted.

In some case of illness, the deterioration is temporary and when person recovers his health, the writing resumes the former level of skill.

vi) Variations due to disguise

A disguised handwriting is one in which the person has made a deliberate attempt to remove or to modify all or some of his normal writing habits. A favorite practice of the anonymous letter writer is to employ disguise to avoid detection. Perfect disguise, of course, would assure complete protection, but perfect disguise is itself extremely difficult. Although it is relatively simple to change one's writing habits sufficiently for one or two words to preclude identification, the task of maintaining an effective disguise grows more difficult with each additional word. When as much as a page of writing is disguised, it is generally true that the writerÂs normal habits are only partially veiled. Under these conditions the disguise may not be sufficient to prevent an identification, especially if a large quantity of known writing is at hand.
Disguised writing has highly characteristics features that distinguish it from normal writing.

1. It usually contains evidence of a conflict, the struggle between persistent, natural habits and the effort to suppress them.
2. Consequently, it is less skillfully executed than the usual writing of the individual.
3. Irregularities and inconsistencies tend to appear.
4. Hesitation, variations in slant, odd and at times grotesque letter forms, patched up portions, and slowly drawn strokes are typical.
5. The prominent features, such as capital letters and slant, size, generally undergo the most marked change, while the smaller, less prominent, though equally important, identifying factors retain their usual character.
6. Some persons have the habit of keeping the manuscript of another person in front and copy the letter designs from the said writing to conceal his own writing habits. Such copied handwriting will lack in fluency and rhythm. In such copied handwriting, it is seen that the final copy is consistent with the specimen writing of the copyist or writer of the original.
7. All these facts bear consideration, for identification of disguised writing is possible only if the unnatural portions are recognized and properly evaluated, while the undisguised portions are used as the basis of the identification.
8. Disguise may be accomplished by writing with the opposite hand from that habitually used, i.e. so-called left-handed/unaccustomed handwriting. It may be a very effective disguise as long as no standards of the wrong-handed writing are available. This method can sometimes be inferred from the relatively low writing skill. In criminal investigations, once a suspect is located, steps should be taken to obtain request writing executed with either hand.
9. It is not possible for a man to introduce the disguise throughout the whole of an extended passage of writing. The writer will be tried with the consequent loss of concentration and will show that some writings are less thoroughly disguised than others. When a letter is received in post it is observed that the handwriting on the envelope is rarely disguised though the writing on the letter inside may be disguised. Figures which form part of the address on an envelope are rarely disguised. Particular attention must be paid to titles in the address e.g. 'Mr.', 'Mrs.', 'Dr.' etc. These titles are not likely to be disguised. And especially the figures in the pin code or figures in numbering the pages will show normal writings. But it need not be assumed that figures are invariably left undisguised: on the contrary the figures in suspicious entries in account books or printed forms are invariably disguised. The criminal will generally try to copy the figures of someone else who has access to the documents of similar types.
10. Disguise is not possible in:

    i) The graphic habits: the order i.e. the layout of the text in page.

    ii) The punctuation ascending small signs or symbols.

    iii) The manner of forming the vowel shapes.

<u>General findings</u>: -

a. The handwriting of a person loses its rhythm and its homogeneity if it is marked by constraint, lack of suppleness; it becomes irregular in all respects (speed, pressure, slant, size etc. It is slowed down).
b. The dimensions are frequently increased; the slant is modified, the line being made more erect or slanted backward.

c. The forms are changed, particularly, the capital letters. Complications increase to the detriment of simplifications. Increase in the frequency of angles.

d. Pressure becomes more irregular and in general more accentuated.

Disguise in figures cannot be said to be complete as the arrangement and alignment in figures of date, month and year will show a marked individuality of the writer.

Sometimes the final passage will bear a closer resemblance to the normal handwriting than the earlier portion written in disguise. Any feature which remains unaltered throughout is probably undisguised. Even the specimens wrote over a fair period of time will show features which can be safely assumed to be undisguised. Consistent disguise is restricted to the more outstanding features of the handwriting and the less conspicuous the characteristics, the less likely it is to be disguised in any way. One should never be under the impression that certain changes are never introduced into the handwriting as disguised.

11) Features which cannot be disguised:

a. It is not possible to disguise handwriting which is of higher quality with respect to fluency, rhythm and letter designs than that which is normal to the writer.

b. It is also not possible to introduce spacing characteristics of the words and inter-letter spacing.

c. Marginal habits, flourished, underlining of word and the use of the erasure are features where disguise is not possible.

d. There is a small group of penmen who write with almost the same ease and skill with either hand. These ambidextrous writings do not suggest disguise for each hand has been drilled to a degree of proficiency that removes all specimens from the class of wrong-handed writing. With each of these persons, writing with his right hand differs from that done with his left. Furthermore, he is generally known to have this unusual ability, and certainly he must have written extensively with each hand in order to acquire the skill. The problem then becomes one of procuring proper standards written with each hand for examination and comparison with the disputed matter.

To be successful in producing a disguised writing the writer must carry out two difficult steps. He must have a thorough knowledge of the identifying details of his writings and the significance of each. This condition is alone seldom fulfilled. Second is the task of eliminating the identifying habits of his writing and adopting an entirely new set. Writing habits are very strong, and serious difficulties are encountered in any attempt to discard them. The usual result of these attempts is effectively to eliminate prominent characteristics but to leave numerous, unconscious, but individual, writing traits. What is then believed to be an effective disguise actually is filled with these small but significant personal habits that may permit an identification of a writer.

vii) Variations due to intoxication

The alcohol intoxication produces abnormal handwriting since alcohol consumption affects the nervous system of an individual which is directly related with the production of hand writing.

The common effects of alcohol consumption on handwriting are-

1. Carelessness in the formation of letters and their connections.

2. Decline in the legibility and tendency to abbreviate letters and even words.

3. Tendency of leaving comparatively more space between the letters and words.

4. Increase in the size of letters.

5. Presence of cuttings and over writings.

6. Spelling mistakes.

The above noted changes due to alcohol consumption may not be present collectively and it should also be noted that these changes can not be solely attributed to the effect of alcohol, and the examiner should be very careful in this regard.

viii) Variations in the signature and writing of the same person

As a rule, the signature should be compared with the signature and writing should be compared with writing(s). The only reason for setting up this rule is that by the repeated use, the signatures of most of the persons become comparatively more individualized and peculiar than their writings and this may cause difficulty in comparison of the letters of signature with the same letters in the writings. However in the cases where the signatures are also written in the same style of the formation of letters as in the writings, then there is no difficulty in the comparison of signatures with the writings.
A signature may very often does possess a great peculiarity, it may be in the form of the letters or in some flourish, which does not attend the writer's general style of writing. The peculiarity is made use of by some persons from mere whim or caprice, by others from a desire to conceal the writer's usual style, or to make his signature difficult to be imitated.

3.4.6 IDENTIFICATION OF HANDWRITING

The identity / non-identity / forgery of writing can be established by the study and analysis of general and individual characteristics of the writing.

CLASS/GENERAL CHARACTERISTICS:-
The general/class characteristics which are common to a group of people such as:

a. Movement
b. Line Quality
c. Skill
d. Speed
e. Alignment
f. Slant
g. Spacing
h. Relative size & Proportion Of Letters
i. Pen Pressure

j. Shading
k. Pen Presentation
l. Arrangement
m. Style
n. Tremors

(a) **MOVEMENT** - The manner in which writing instrument is moved with the help of fingers, wrist and arm. The principal movements in writing are:

(i) Finger movement

(ii) Wrist movement

(iii) Forearm movement

(iv) Whole arm movement and their various combinations and gradations.

(i) **Finger Movement:** The finger movement is that method of writing in which the letters are made entirely by the action of the thumb and the first and second fingers. This is the movement employed by children and illiterates and generally by those with whom writing is an unfamiliar process.

The finger movement gives very slight lateral freedom as the portion of the hand rest on the paper permitting very little freedom in the process of writing. Finger movement writing shows:

(a) Lack of clear-cut smooth strokes and rhythm

(b) Presence of broad curves

(c) Irregular connections between letters and part of letters.

(d) Slow, speed, poor skill & heavy pen pressure.

(ii) **Wrist Movement:** The wrist movement writing is that produced by the action of the hand as a whole with the wrist as the centre of action, but with some action of the fingers. The wrist movement writing exhibits:

(a) Narrow or angular connections at the tops and bottoms of letters,

(b) Fine terminals of the letters.

(c) Well defined letters.

(d) Medium speed, skill & pen pressure.

(iii) **Forearm Movement:** In this movement the writings are produced by the movement of hand and arm with the elbow resting on support as centre of motion.

Many superior persons write in this manner. Forearm movement writing shows:

a) Smooth, clear-cut, symmetrical, rapid strokes

b) Rhythm, a uniform base line and gives great command of hand and the most complete lateral freedom.
c) Flying starts and tapering terminal and fine graduated pen pressure.

d) It is in the style of writing that is forged with greatest difficulty for the reason that method by which it is produced is farthest removed from that slow drawing motion employed in carefully following a copy.

(iv) **Whole arm Movement:** The whole arm movement in writing is the action of the entire arm without any resting point. It is employed in very large writing, in ornamental penman ship, in black board writing, and by a few writers in making all the capital letters.

(b)LINE QUALITY - Line quality means the condition or quality of the strokes and curves which form the letters. It is derived from a combination of factors including writing skill, speed, rhythm, freedom of movement, shading and pen position. Line quality is the fundamental importance as its nature in the writing tells whether such writing is an imitation, a disguised one or a normal one. Normal writing will show in certain parts the edges of the strokes are clear-cut and firm and the width of the stroke is uniform.

Most forgeries are defective in line quality, particularly with regard to curves and elongated terminal strokes of letters and the connections between letters in a word. Simulated forgeries will show that the edges are not clear-cut and sharp, the width of strokes may not be uniform and there may be evidence of re-touching or lifting of the pen at unlikely places.

RHYTHM - A handwriting which shows regularity in size and slant of the letters, clear cut quality of the strokes, graceful formation of the curves, smooth and symmetrical construction of the strokes and rapidity of the motion is defined as a rhythmic writing. Rhythm cannot be initiated.

MOVEMENT IMPULSE - Movement impulse is an important characteristic of writing. It means change of direction while writing a particular letter.

A free, uninterrupted motion naturally makes a smooth, uniform, continuous curved or straight line, while a change of direction, stop, tremor, or unevenness in the intermediate part of what ordinarily is a single stroke indicates a hesitation or changing movement impulse Fig. 1.

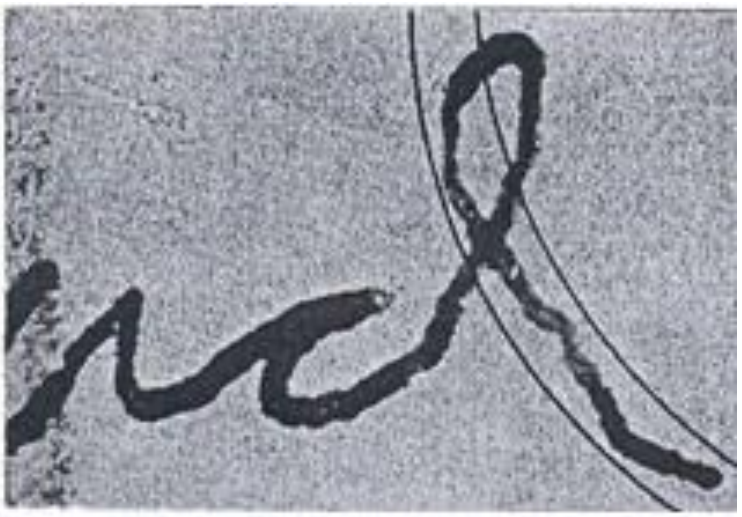


Fig. 1: Hesitations

(c) SKILL - Skill is the proficiency or ability of the writer to execute the strokes or letters and is reflected through legibility, symmetry and pictorial aspect in writing.

Skill in writing may be divided into three broad categories:

- Poor
- Medium And
- Good

In hand writing analysis the forged or simulated writing cannot be skillful.

(d) SPEED - Speed in handwriting means the ease and freedom with which the pen moves on the paper. It depends upon the skill of the writer, quality of the writing materials and instruments etc. The rapid speed might result from the higher degree of the movement, i.e. the forearm movement. Speed is the relative term and is judged from the quality of the strokes and it is directly related with the movement. The higher the movement, the greater the speed. When two writings are to be examined it may be possible to say which of the two is of greater speed.

It can be interpreted in broad terms as:

- Slow
- Deliberate,
- Average And
- Rapid.

(e) ALIGNMENT - It is the relation of the successive characters of a word, signature or line of writing, to an actual or imaginary base line. In many writings the quality of alignment is a characteristic of much significance and shows many unconscious, individual habits and should always be carefully considered in examining writing.

Those who write with elbow as the centre of lateral motion and hold the arm at right angles to the line of writing often write words almost perfectly aligned and straight across the page even on wide un-ruled paper.

Those who write with wrist as centre of the motion may write lines made up of short arcs of a circle representing the reach of the hand, or Pen scope, with the wrist at rest when moved around to the right as far as the hand will reach.

When the position of arm and the paper is not at right angle but remains in opposite directions to the right or left side, the alignment of writing will be uneven throughout.
The alignment of writing or signature is classed as:

- Ascending (Uphill),
- Descending (Downhill),
- Even (Horizontal),
- Arched,
- Garlanded And
- Irregular.

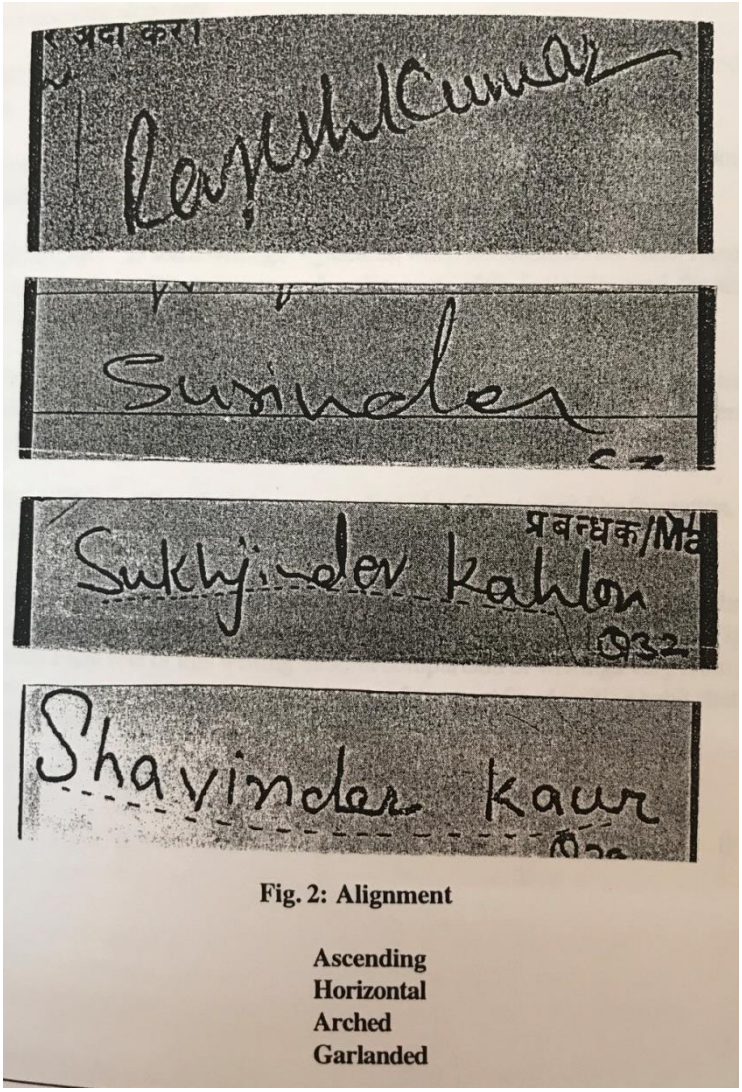


Fig. 2: Alignment

Ascending
Horizontal
Arched
Garlanded

ASCENDING - The line of writing/signature which has a tendency of rising upward to the actual or imaginary base line is called ascending alignment.

DESCENDING - The line of writing/signature which descends to the actual or imaginary base line is called descending alignment.

EVEN - The alignment which regularly proceeds straight is called as horizontal or even alignment.

IRREGULAR - In some writings/Signatures, when the letters do not show fixed positioning i.e. when some of the letters ascends and/or some of the letters descend, the alignment is called irregular alignment.

ARCHED - In the writing/signatures, when the letters are positioned in such a manner that they form arc like formation with the actual or imaginary base line, the alignment is called arched alignment.

GARLANDED - When the letters are positioned to form trough like formation, the alignment is known as garlanded alignment.

(f) SLANT - The angle or inclination of the axis of letters or their strokes with the actual or imaginary base line is known as slant. It may be either left, vertical or right (Fig:3) The importance and role of this writing habit in comparison of writings vary from person to person, however, with many writers it is one of the most fixed writing habit that becomes highly important or significant under certain conditions.

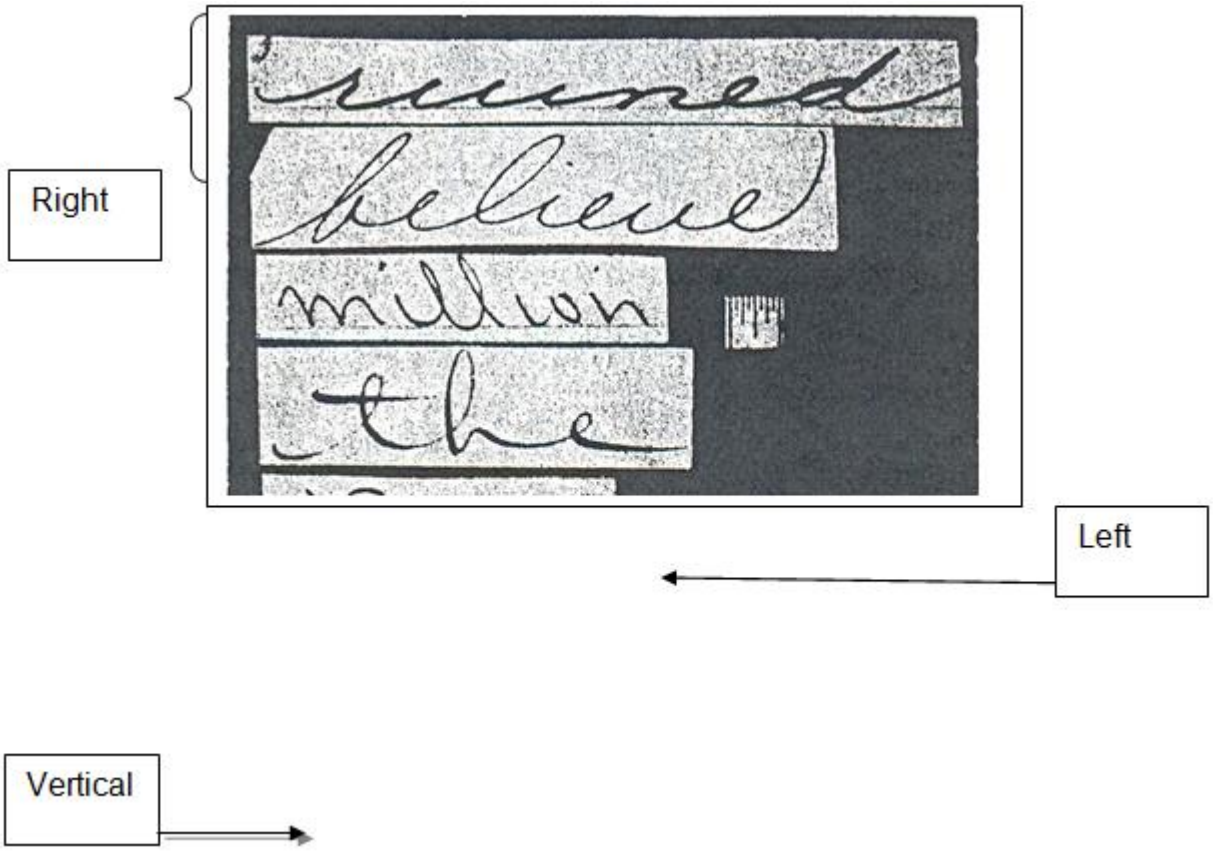


Fig. 3: Slant Letters with Right, Left and vertical slant.

A slight but persistent difference in slant in two writings of considerable length may be

evidence that the writings are by two different writers.

Slant is the most popular technique of disguise. A writer, if he changes his slant of writing from left to write or vice-versa he makes his handwriting less skilful and the element of disguise can be judged from the variation in the slant beyond tolerance limit.

To determine whether the differences in the writing slant in two sets of writing are due to disguise or due to their non-identity is based on some important well established principles.

1) When the difference in slant in two writings of considerable length is slight, and this difference is persistent or consistently maintain then this points towards the non-identity of writings and not disguise.

2) A deliberate change in the writing slant with an intention to repudiate identity cannot be maintained in the writing of considerable length and writer generally reverts to his normal writing slant.

Another habit with some writers is that, habit of writing different slant for different letters. If this writing characteristic is persistent, it has strong identifying value.
The slant can be measured with transparent protractor.

(g) SPACING - Spacing is the distance between letters in words, space between words and space between lines of writing.
Although this writing habit becomes almost fixed habit in the normal writings of an individual, however, sometimes when the available space for writings is lesser or the writer has to cover comparatively more area (such as signatures over revenue stamps), the spacing may get affected. If two genuine writings show such variations in the spacing between letters, words or lines and those variations can be explained, then such variation may be immaterial.

IMPORTANCE OF SPACING IN FORGED DOCUMENTS

It is a common practice in India that signature or thumb impression is fraudulently obtained on a blank paper and body writing is written or typed above that signature or thumb impression to make a document. In such cases, it is normally not practically possible to adjust the matter of the body writing in the available space above the signature or thumb impression and the preparator has to increase or decrease the spacing between letters, words, lines or paragraphs according to available space. In these types of fraudulent documents bearing genuine signature or thumb impression, the spacing may play a significant role and this factor may be sufficient to prove that the document is not genuine.
In case of fraudulent additions, alterations or interlineations, the added matter may not be properly adjusted in the original writings and the inconsistencies in the spacing may at once reveal the fraud.

(h) RELATIVE SIZE AND PROPORTIONS - Although overall size of writing may increase or decease, but the habit in regard to the relative size of one letter to the other letter(s) is almost a fixed habit and it remains fairly constant. Even in disguised writings showing intentional increase or decrease in the size, the proportions of letters have been

found to be corresponding with the proportions in the normal writings of the writer.

Some writers are in the habit of writing some letters abnormally longer or shorter than the other letters and such habit remains persistent even under different sets of circumstances.

The writing proportions are:

1) Relative height of letters.
2) Proportion of the height and width of the same letter.
3) Proportion of height of letter to the length of the word.

The proportions of letters can be determined by observing the relation of letters under rule squares of transparent medium such as glass etc. and to photograph them for demonstration purpose.

(i) PEN PRESSURE - Pen pressure may be defined as the pressure or force applied on the writing instrument during the process of writing.
The main characteristics of fountain pen is that it has two flexible nib points which produce lines of varying width depending mainly on the flexibility of points and pressure applied during writing.
Most of the modern fountain pens have comparatively stiff nib points which restrict shading and produce strokes comparable to the uniform strokes of porous tip pens. The fountain pens deposit liquid inks which tend to penetrate deep into the paper fibers.

The fountain pens with broader nib points give comparatively more shaded strokes and the nature of shading also depends upon the angle of pen with respect to line of writing and the surface of paper i.e. when the nibs are at right angle to the direction of strokes, the shading will be different than the shading produced with the nibs parallel to the direction of strokes. Comparatively lesser number of fountain pens available in the stationery stores today has broad tips rather most of the pens have less flexible fine writing tips.
Every writer applies the degree of force on the pen that will enable to write in a comfortable and normal manner. And, the degree of force becomes a habit with every person. The acquisition of the habit of pen pressure is automatic and unconscious.

Pen pressure in a signature or writing can be seldom simulated by the forger at the exact location(s) and in correct degree due to the reasons that firstly a forger normally does not give attention to such a minute and hidden characteristics and secondly it is beyond the powers of a forger to apply similar pressure on the writing instrument and give similar emphasis at certain points which are employed by the actual writer by virtue of his habit acquired by long practice and individual taste.
Pen pressure can be classified as:

- Light pen pressure.
- Heavy pen pressure
- Medium pen pressure
- Graduated pen pressure
- Uneven pen pressure.

LIGHT PEN PRESSURE - The application of light pen pressure produces fine and narrow strokes as the pen points have not penetrated deeply into the paper. The ink deposited or banked up on either side of the furrow mark or white track is light in density. This type of writing pressure is generally applied by skilled writers having good muscular co-ordination and command over the writing instrument. The light pen pressure in writing is usually accompanied by fast speed and well defined curves.

HEAVY PEN PRESSURE - When heavy pressure is exerted the furrow marks are more easily viable and the ink fluid banked up on either side of the tracks is thick in density.
The heavy pen pressure is generally applied by the children in the initial stages of learning to write, by illiterates, by forgers and by the persons for whom the act of writing becomes a difficult task due to one or the other reason. The application of heavy pressure results in slowing of speed, broad strokes, heavy shading, blunt starts and blunt terminals. The heavy pen pressure may also cause indentations in the paper if writing support is not too hard.

MEDIUM PEN PRESSURE: In medium pressure all the strokes are of the same density in the writing.
The degree of pen pressure which lies in between the light and heavy pen pressure is referred to as medium pen pressure.

GRADUATED PEN PRESSURE - This means Gradual increase or decrease in the width of the strokes. The well skilled writers sometimes employ graduated pen pressure to produce fluent and rhythmic writings. In such writings the pen pressure is well graduated in harmonious manner according to the individual taste of the writer.

UNEVEN PEN PRESSURE - In irregular or uneven pressure the ink deposited in some strokes is heavy while in other strokes the ink is of lighter density. Lateral pressure is indicated when the lateral or horizontal strokes are of greater density than the angular strokes. Initial pressure is indicated when the ink of the commencing part of the first letter in a word is of greater density than rest of the letters.

Pen pressure is applicable only to pen and ink writing not to pencil, ball pen or feather/fiber tip pens.

(j) SHADING - The variations in the width of the strokes are known as shading. The degree of pen pressure is judged from the width of strokes. Shading is considered to be the visual record of the manner in which the pen was moved on the paper i.e. the angle at which the pen was held with respect to the writing surface and with respect to the line of writing, pen pressure applied and the emphasis of the pen at particular points.

Shading gives grace to the writings. The letters having well graduated shading appear more lively and pleasing than the letters portraying rough or irregular shading.

Shading habit is an involuntary act personal to each writer, resulting from his individualized habit of holding the pen at certain angle, applying pen pressure and twisting the pen at curves according to his ability and taste. Some writers shade all the strokes in a smooth manner, some writer's shade the strokes in artistic manner with well graduated application of pen pressure, some writer's shade the initial parts of strokes while others are in the habit of shading lateral parts of strokes. The shading may be smooth, graduated, rough and irregular, heavy, explosive or bunchy, rare or accidental.

There is a close relation between shading and movement because shading necessarily

interferes somewhat with speed, although not with continuity and smoothness. Clear-cut smooth shades especially on curves show a free and well controlled movement, and simulated or traced writing is nearly always defective in this particular feature. Being self- conscious and hesitating, it lacks the smoothness and directness that are characteristics of genuineness.

In traced and simulated forgeries, the forger attempts to reproduce the design of letters of the model signature which is a slow and conscious act. He fails to reproduce the shading in correct order and sometimes when he realizes the importance of shading, he tries to shade the strokes by retouching and patching them carefully. It is a settled principle that it is exceedingly difficult to simulate the shading in correct form and the forgers fail in their attempt to copy this habit of writers.

(a) PEN POSITION - The position and angle of pen with respect to writing surface as well as with respect to the line or direction of writing.

The manner and angle of holding the pen are the most individualized and fixed writing habits and can neither be easily disguised nor copied or simulated. The reason for the first assertion is that the manner of holding the pen becomes so fixed and the writer becomes so accustomed to hold the pen at a particular angle that it becomes most difficult if not impossible for him to leave this habit and adopt a new style of holding the pen in a different manner at different angle. The second assertion is based on the simple reasoning that the forger does not understand the significance of the manner of holding the pen and he cannot assess and then adopt this writing habit of another person by discarding his own fixed and individualized habit of holding the pen.

PEN PRESSURE, SHADING AND PEN POSITION IN BALLPOINT PEN WRITINGS

The ball -point pen has a hard non-flexible writing tip i.e. a small rotating ball, which rolls the ink on the surface of the paper. The rotating of the ball tends to produce a small depression in the center of strokes and when a weak pressure is applied on a ballpoint pen, only the tip of the ball touches the paper producing a narrow stroke. When one writes with heavy pressure and the writing support is not too hard, the ball depresses the paper and its major portion comes in contact with the paper thereby producing wide stroke. It means that when the nature of writing support and other factors are same, the width of the strokes is directly proportional to the pressure applied on the pen.

The non-flexible quality of the ballpoint should produce handwriting devoid of shading or evidence of pen emphasis. This is not entirely the case. Granted the pen gives a more uniform width line, but some writers can nevertheless produce handwriting with a ball-point pen which reveals clearly differences in writing pressure.

Since the writing i.e. the ball of a ball-point pen is rounded, therefore the angle of pen does not seem to cause any appreciable change in the nature of strokes, hence the pen position cannot be correctly determined in ball-point pen writings.

PEN SCOPE

Term ‘Pen-Scope’ refers to the distance traveled by the pen from one point to other point without changing the pivot. It largely depends upon the lateral freedom of writing instrument with respect to pivot.

In finger movement, hardly one stroke or letter can be written without shifting the pivot; therefore, the pen scope is very limited. In forearm movement the distance between the writing instrument and pivot is more and there is more lateral freedom, therefore, the pen scope remains much extended. In examining writings, the number of letters written in one operation without lifting the pen and changing the pivot should be counted which may provide a corroborative factor regarding their identity or non-identity.

Briefly stated `pen-scope` or pen-travel is the distance traveled by the pen, without lifting the hand from the paper, or without changing the fulcrum or pivot of the hand. The higher the movement, the greater the pen- scope.

(k) ARRANGEMENT - The habit of arrangement of words, sentences and paragraphs in the writing is the outcome of several reasons such as artistic ability, education, environment and the degree of expression of certain mental traits etc. This habit is consciously acquired at the initial stage but when it is fully developed, it becomes automatic and it is considered as one of the fixed and important writing habits. The arrangement of letters and words made unconsciously with automatic and usual habit of the writer is the most important characteristics in studying the peculiarity of one's habit of writing.

Just as arrangement of strokes and curves give shape to a letter, so the arrangement of letters and words and the method of writing a sentence with regard to size and spacing produce an important factor for examiner to compare handwritings and determined their identity or non-identity.
Arrangement Examination-Main points:

1. The general arrangement of writings on a paper and style of paragraphing.
2. Spacing between letters, words, lines and paragraphs.
3. Nature of alignment of lines whether even, uphill or downhill, irregular or arched.
4. Placement of signature(s) with respect to writings.
5. Nature of margins etc. at left, at right, at top and at bottom of paper.
6. Location of punctuation marks with respect to the base line or apices of letters.
7. Relation of capital letters with regard to small letters.
8. Arrangement of headings with reference to the body of paragraph.
9. Parallelism and width of space between lines of writing on envelope addresses, or on un-ruled paper.
10. Arrangement of figures and abbreviations, dollar and sent signs, etc. to line of writing and preceding or following writing;
11. Interlineations and their character, position, frequency.
12. No. of words to a line as in telegraphers writing.
13. Underscoring and its location, frequency and emphasis.

(l) STYLE - Style is a complex characteristic. It is, in the first place, the fixed design of letters which includes the manner of writing.

The one taught from printed copybooks is called the copybook style. Indian scripts have usually one copybook style taught in schools. As one practices writing, he cannot, however, attain the perfect form and quality of the copybook style. As he progresses, the style is modified by his skill, taste, whims, occupation and environment. As he

attains graphic maturity it becomes individualistic, though it retains the basic character, to some extent, of the original style followed. We have already note the different movement patterns. Since style is the overall nature of letterforms, it is classified according to the shape of form as (1) rotund, (2) elliptical or oval, (3) angular, and (4) squarish. With regard to connections we classify it as cursive and detached. Angular style represents angular movement pattern. Based on the movement pattern, there are the vertically expansive style and laterally expansive style, legible style and degenerate, illegible style and so on.

Style is thus connected with the movement pattern. It is the overall aspect of the visible forms and in a way it describes the basic movement pattern. For this reason style is as important as the movement. It is on the basis of style that the major classifications of handwriting are advocated by Lee and Abbey.

It is very difficult and almost impossible for a person to write two different individualized styles of writing with equal skill and without inter-mixing their characteristics. There is rarely a fundamental change in the individual style attained. Any deliberate change in style characteristics will at once make the writing unnatural and inferior in quality. One may try to acquire a new style by regular practice with scrupulous care and painstaking effort. But to overcome a settled habit of one style and to cultivate a different habit of a different style, requires that the later habit must be far more powerful than the former. Even then, there is no guarantee that the newly acquired style does no imbibe some of the characteristics of the former style. As such the proposition that a person can write two different individualized styles is farfetched and it has no valid basis.

Of course some persons make their signatures in more than one style. But, in most cases one style is the ordinary writing style and the other the idiosyncratic. Very rarely one makes his signatures in two equally highly individualized and idiosyncratic styles.

Style characteristics are the most obvious features in handwriting and therefore account for the general pictorial appearance. If any of these characteristics are changed the general appearance of the writing changes. For example, a change in slant gives a different appearance to the writings.

(m) TREMOR - Deviations from uniform strokes ordinarily called tremors, which are perfectly apparent without magnifications, or due to lack of skill on the part of the writer, to self-consciousness of the writing process, or to be hesitation which is the result of copying or imitating. Natural tremors due to old age or weakness etc. clearly show muscular weakness and writing movement beyond the control of the writer. Presence of sudden departures in the line, abrupt recoveries and other irregularities are main indications of natural tremor. Even some parts of a letter(s) itself may be omitted and no attempt is made to correct them.

The characteristics of tremor of fraud, as distinguished from other tremor, are inequality in movement at any place in any stroke or line, with strokes too strong and vigorous combined with weak, hesitating strokes; also frequent interruptions in movement, unequal distribution of ink on upward as well as downward strokes, and especially the varying pen pressure, due to change in speed and interruptions in movement, which may occur in the middle of direct curves, or even in what should be straight lines. The

tremor of illiteracy shows general irregularity owing to hesitation, uncertainty and unfamiliarity with the writing process. Unsymmetrical strokes in writings, irregular alignment, abnormally larger or smaller letters, absence of skill and rhythm are other important features.

- Tremors of old age, illiteracy and weakness are not generally distinguishable from each other but they can be distinguished from the tremors of forgery.
- Natural tremor does not appear suddenly in the writings or signatures of an elderly person but it is the outcome of gradual decline in the physical strength.
- It is almost impossible to successfully imitate or trace natural tremor.
- Natural tremor is an involuntary movement, which cannot be controlled by the writer.
- Tremor of illiteracy is not due to muscular weakness rather it is due to the lack of skill and uncertainty as to the formation of letters.

INDIVIDUAL CHARACTERISTICS

A characteristic that is highly personal and peculiar and is unlikely to occur in other instances which lead to an unmistakable identity of two writings is called as an individual/personal characteristic.

It is a matter of common knowledge that hand writing becomes individualized from the time the child learns the art of writing. Individuality is the basis for the identification of handwriting. The mental and muscular deviations result in a nerve muscle reaction pattern and give the writing its individuality. As the writing matures it is modified by the factors like education, training, personal taste etc. But once the form of letters and their manner of execution get established by usage, the writing becomes automatic and unconscious, which is a reflex action.

A reflex action - The beginners first conceive a mental picture of the forms of letters which they have to produce, and then they try to imitate the same on the paper consciously. After persistent practice the habit of consciousness disappears and unconscious manner of producing developed writing is formed which is described as a reflex action of the mind.

The changes in hand writing developed by use may affect nearly every character and finally produces that surprising individual variation.

These individual characteristics which themselves reflect individuality, are rare, mainly unique, inconspicuous form variations and they are so numerous. Their rarity and peculiarity depends on the nature of their divergence from the copy book from.

They result largely due to:

1. The survival of an error over looked by the teacher;
2. Conscious or unconscious influence of others writings;
3. Admiration for a particular design;
4. Necessity of purpose as in the case of fluent and rhythmic writings, degeneration due to speed or inaccurate memory as in the case of an illiterate writer;

5. Idiosyncrasies developed by use. These produce surprising individual variations by which handwriting is most positively identified. These develop in many ways, two of which are abbreviations and embellishments.

Abbreviations: Standard abbreviations like Mr., Mrs., Dr. etc. may be idiosyncratic. Other abbreviations of letters or combinations of letters or monogrammatic formations result from taking away what are considered to be the unessential parts or distorted mental conceptions or from the coalescing of letters. These are individual idiosyncratic inventions. When a person gets tired, he is likely to omit parts of some words. Such omissions shall not be mistaken for habitual abbreviations.

Embellishments/Flourishes:-These are extensions of strokes which naturally develop out of facility, freedom and flow and individual fancies. These are in many cases unconsciously made and hence provide evidence of genuineness or otherwise. In the examination of anonymous writings, these should be carefully observed and evaluated.

Inconspicuous Characteristics

The various inconspicuous characteristics are important mainly because they are inconspicuous. Naturally they are not readily seen and understood because the power of human eye is very limited. It cannot observe things which are too small and hidden. It, by itself, cannot observe the minute differences in size, slant, length, curvature and proportions. Unaided, it cannot also see the subtle differences in shades of ink, the nature of edges of strokes, the hidden signs of forgery, the differences in the width of strokes and cannot detect the erasures, over writings, and altered writings etc. Therefore the aid of various measuring and magnifying instruments like scale, protractor, magnifying lenses, microscope, U.V.rays, I.R.rays and employs different techniques of illumination to extend the power of the eye beyond its natural limit and to enlarge the field of observation. Hence the examination under magnification by using different hand magnifiers, illuminated magnifiers of different powers is essential.

Inconspicuous characteristics are subject to vide variation and include some of the most difficult forms and combinations in handwriting.

These important but inconspicuous characteristics are:

a) The shape, position, angle, and height of connecting strokes between the small letters given below and the following letter in a word: (1)b, (2)f, (3)o, (4)p, (5)s, (6)v, (7)w. Form of final small letters (8)w, (9)of r; the form, shading, crossing, and height of (10) initial small t, and (11) final small t; the initial and intermediate (12) small letter a; the form of (13) initial and intermediate small 'c': the form of (14) initial, and final letter o; the form of (15) initial and final s; the distance that sharp angles are retraced at base of letters (16) m,n, (17) h.

b) The second group of inconspicuous characteristics, as important perhaps as the first, are: The length, width and slant of the (18) upper loop letters l,b,h,k, and f, compared with the shortest or one space letters and also as compared with the lower loop letters g,j,y,z. The height of separation above the line of the two strokes of the small letters (19) b,h, l and ‘t’ at the beginning and also in the middle of words. The distance that (20) up strokes are traced back at the sharp angles in the connections at the tops of letters, ‘a,g,i,j,s,w,u,y’ the length, slant, direction, and exact shape of (21)

beginning strokes of all words; the same of (22) ending strokes of all words; (23) exact location of shading on all loop letters; (24) the ovals of small 'a' and 'o' and their manner of connection with preceding and following letters; (25) position, form and size of all figures, all punctuation marks, and signs &, $, C, and all other abbreviations; the character and location (26) of all embellishments, flourishes, or added or extra strokes of any kind; and finally (27) all abbreviated, shortened or defective letters or characters of any kind. (28) The diacritics of letters 'i' and 't'.

c) Rubric is an ornamental stroke which often includes the underscoring of a signature. It exhibits in many cases an individual peculiarity.

d) Underlining: Some persons have the habit of underlining words which they consider need emphasis. Many people underscore their signatures. This underlining the signature in particular shows individual features. Besides the underscoring there may be dots placed below it which also have an individual significance.

e) Pen lifts and connections: The places of pen lifts are prescribed in the copy book style. But as in the case of forms, the writer deviates in this respect also. Particularly in detached scripts, obliged by the necessity of speed and continuity, he ignores the rules and develops his own habit of lifting the pen depending on his skill and feeling of facility. There may not be a perceivable habit of pen lifts as a whole in some cases, but many writers have a fixed habit of lifting the pen after certain letters.

A writer's feeling of facility, however, is not static and may vary with the kind of instruments used and also with the conditions in which he makes the writings. As such the number of pen lifts may not be the same in two verbatim writings made by the same person. What is therefore important is a noticeably fixed habit of lifting the pen.

Connections are the opposite of pen lifts. These are of two kinds.

i. One is the joining of two stokes i.e. downward and upward strokes or upward and downward strokes (an instance is the letter 'm').
ii. The other is the joining of letters or words.

These connections may be angles or curves. The later may be arcs of circles or ovals. The degree of curvature has a considerable range and in some cases the connections may be flat as a straight horizontal stroke. The connections have a great significance in as much as they represent the movement habit and also contribute to the general appearance. They signify, in their own turn, they style and the spacing, the skill and the speed, the quality of movement and writing. A change in the connections affects the general appearance of the writing.

(f) Spelling mistakes may be due to habitual mispronunciation or to some personal misapprehension or the word being unfamiliar. A number of people commit spelling mistakes of some difficult words. Though the writer knows the correct spelling he may inadvertently commit a mistake which may probably be due to haste, fatigue or thought overtaking the movement (or what we may call the leaping forward of the mind). But what is significant is a consistent misspelling particularly of simple words. That is, must show a habit.

(g) Use of Particular words or Phrases:- In anonymous letter enquiries this factor sometimes assumes significance, particularly if the words are uncommon and are

repeatedly used.

Various qualities in writing also grow out of the purposes for which writing is used and the amount of writing done. One who writes much will develop many individual qualities, while the one who does practically no writing will continue to write the general system acquired in school which, however, usually degenerates somewhat and finally becomes the quite well marked style of the uncultured and illiterate.

Another important quality of handwriting in this country is the presence and the influence of foreign handwritings.

The fact to be kept in mind in a handwriting investigation is that the genuineness or the identity of handwriting is determined by the number and nature of its characteristics and a positive opinion is not given by the competent witness unless an adequate amount of standard writing for comparison is supplied.

3.5 FORGERIES AND THEIR DETECTION

The average unaided or so-called naked eye can distinguish or, optically speaking, resolve, separate lines up to a fineness of only about 200 or 250 to the inch, lines finer than this appearing as solid mass or tint. The microscope is the instrument which makes it possible to see physical evidence directly that otherwise might be invisible or cannot be distinguished by the naked eye. There is great variety of questions which only microscope can answer. In many instances it's evidence is conclusive. The microscope serves to discover and show the physical fact by direct view of the thing itself.

A STEREOSCOPIC MICROSCOPE is essential for serious work on documents. This type of microscope is unique in that it gives a stereoscopic or three dimensional images which are vital for many types of investigations. Great enlargement brings with it a correspondingly small field of view and a reduction in the stereoscopic effect. In certain inquiries the principle employed in stereoscopic microscope or what is known as binocular vision, is very useful. The microscope consists of two complete microscopes so arranged that they focus on exactly the same image; the combined two-eye view gives the true stereoscopic effect and in certain kinds of inquires is of very great assistance in showing the exact facts. In this instrument the image is not inverted, a large and brilliant field of view is provided.

A microscope of this kind particularly useful in studying any question in which depth or the third dimension must be considered such as to study the line quality of strokes as in the case of simulated forgery, writing over folds, crossed line inquiries, questions regarding seals or any impressed characters, or erasures by abrasion the stereoscopic microscope often will demonstrate clearly what otherwise cannot be proven.

A: FORGERY: Forgery means making of a false document with intent on the part of its maker to defraud.

Or

Making of a false document or tampering any part of a document, dishonestly or fraudulently to support any claim or title.

Or

Who dishonestly makes, signs or executes a document or part of a document, or makes any mark denoting the execution of a document with the intention of causing it to be

believed that such document or part of a document was made, signed, sealed or executed by or by the authority of a person by whom or by whose authority he knows that it was not made, signed, sealed or executed.

The problem of identification is inseparably related to the problem of forgery. The necessity for a scientific identification of handwritings or signatures arises from the fact that forged documents are often presented as genuine and that genuine documents are sometimes attacked as forged. Usually signatures are forged; for, firstly, it is the signature that authenticates a document, and secondly it is relatively easy to forge only the signature rather than to forge the whole document.

The validity of documents involving transfer of money and property, like cheques, drafts, receipts, bills, agreements, sale deeds, will etc. rests mainly on the signatures of the executants. Many claims and disputes, therefore, centre round the signatures. The possibility of forgery necessitates the examiner first to verify whether the questioned signature shows evidence of forgery or of genuineness. In any enquiry the first step is the understanding of the nature of the questioned signature (or writing) and the psycho-physiological factors behind its production, before its actual comparison with the standards are made.

When forgery of a signature is alleged it is natural to ask what kind of forgery it is and how the process or method by which a fraudulent writing is produced may show itself.

B. TYPES OF FORGERIES: For the purpose of the subject of identification and comparison of signatures and writings, forgeries may be classified as –

1. Simulated or copies forgery/simulation by memory.

2. Traced forgery.

3. Freehand forgery (forgery without model/impersonation),

4. Transplanting revenue stamps bearing a genuine signature.

5. Utilizing a genuine signature (Built-up)

The purpose of a forger is to make a signature as similar as possible to the model genuine signature so that one may be taken in by its general appearance. That a forged signature resembles a genuine signature in some ways, particularly in its pictorial appearance, means that some of the characteristics constituting pictorial appearance are introduced into it. In a traced forgery even the details are produced. Laymen are usually carried away by similarity in those characteristics, though vaguely perceived as a whole in the pictorial effect of the signature. But the trained examiner is not deceived; he sees through this surface resemblance and detects a forgery.

What is it that the examiner relies on in determining the evidence of genuineness or forgery? Certainly it is not the graphic similarity of characteristics, nor the number of such characteristics. He looks to their nature and significance and the significance of characteristics is assessed only by understanding their nature with reference to the

movement back of form and the mental background of writer. That is, the examination begins with the probing into the psycho-physiological factors that are responsible for the production of the signature in question.

Here it may be repeated that a correct interpretation is possible when we know the causative factors or the casual connection, for it is judging the cause from the effect; from physical quality to movement and mental background is the rule. The act of forgery is different in many ways from the act of making a normal genuine signature. A person makes his signature almost automatically out of habit. Neither is the unfamiliar with the movement involved in making his signature nor does he need to pay any conscious attention to it. He writes with his habitual movement, speed and skill so that the various characteristics in his signature reflect these qualities and also his writing individuality. A genuine signature therefore exhibits, as a rule, freedom, flow, smoothness and energy.

A genuine writer does not need any prior preparation; he just picks up the pen and makes his signature. An initial ink failure suggests absence of prior preparation and is therefore one of the indications of genuineness. Flying starts and vanishing terminals also suggest the absence of prior preparation and a speedy execution without attention to the writing process. So also a fly-off of the pen in the middle of a flourished stroke which points, in addition to speed, a delicate habitual gradation of pressure.

Since the writing is made automatically out of habit the writer is unmindful of the writing process. It is neither necessary nor is it his intention to make the signature faithfully conform to any of his other signatures. A genuine signature differs graphically in many particulars and this is the natural variation. A genuine writer pays no attention to these varying details. He does not think that this natural variation makes his signature unacceptable; in fact, he has no reason to doubt the validity of the signature which he makes. Inattention to details and natural variation are positive signs of genuineness.

Sometimes a genuine writer may overwrite or retouch his signature when he thinks that such overwriting or retouching is necessary for clarity and legibility; and he does it with usual carelessness. Genuine overwriting or retouching is as careless an act as the writing itself and is necessarily obvious. This is so even when the writer is in the habit of frequently overwriting or retouching.

Since a genuine writer is not conscious of the writing process and writes with his normal speed and energy, the line quality would be clear cut and the writing has a live appearance with strength and force. These qualities coupled with carelessness are signs of genuineness.

The writing of a person is liable to be affected in some measure by the instruments used and the conditions surrounding the writer. Here again the writing exhibits the carelessness of the writer as to the selection of the instruments and the kind of writing produced. The line quality may be scratchy and broken in the case of a bad or defective nib or degenerate and illegible or may show repetitions, omissions, abbreviations, overwriting or corrections which are necessarily obvious. The careless abandon of a genuine writer would also be evident in his failure to correct any mistakes or ink failures. Anything that suggests the careless abandon of the writer is indicative of genuineness.

If a genuine writer is used to write a shaded writing, the shading in such writing would be well placed and consistent.
On the other hand, forgery is a conscious act. A forger is neither familiar with nor used to the movement habit of the signature which he intends to forge. *He gets hold of a genuine signature, looks at it and tries to understand its form, details and execution in his own light and then tries to produce the signature as similar as possible to that model signature and as best as he could.* It is always a double process. The forger firstly needs to avoid his own characteristics and secondly to adopt another's. This double requirement keeps him always conscious of the model signature on the one hand and the process of his writing the signature on the other.

This consciousness and the desire to follow a particular track or movement pattern invariably slows down the writing process and results in defective line quality. The first thing an examiner looks to is the line quality, the importance of which needs no emphasis. From it is inferred the nature of movement and the mental background i.e. the consciousness or otherwise of the writer to the writing process. Defective line quality is therefore one of the most important signs of forgery.

The fear of punishment in doing such an illegal act also disturbs the forgery. The reflexes of his mental tension also make the imitation difficult and thus he does not achieved perfection.

The writing process being slow, the beginnings and endings tend to be blunt. Often they suggest the drawn movement and hesitation and therefore point toward forgery. No forger would be so foolish as to do on the spur of the moment, without much thinking and preparation, a complicated job such as forging a signature involving an unfamiliar form and movement pattern. On the contrary he is anxiously careful and excessively meticulous about the selection of materials and necessarily makes trials till he gains confidence that he can forge the signature satisfactorily and make it pass as a genuine one. Forgery therefore is, as a rule, a careful act of deliberation and preparation. It is for this reason initial ink failures and scratchy strokes contraindicate forgery.

A person disguising his writing is also conscious of the writing process, but a forger's consciousness is something more than that. Disguise does not require following a particular track or adopting another's writing characteristics. It is limited to avoiding one's own characteristics. Further a forger knows that forgery is a criminal act punishable under law. All forgers are not professionals; many of them are beginners and novices. One who for the first time sets himself upon committing a forgery is usually constrained by moral inhibitions. And all forgers alike have the fear of punishment on detection and consequently become disturbingly anxious to perform the act well so as to avoid detection. The consciousness of a forger is mixed with fear and anxiety which noticeably disturbs the co-ordination of movement reflexes.
It may be that a hardened or professional forger largely gets over this fear-anxiety complex, yet the task does not become any easier. Forgery is not a regular act; and a forger, every time he commits a forgery, may not be forging the same person's signature. The unfamiliarity about the movement habit of the signature to be forged continues to be a problem to the forger. He is therefore bound to be critically conscious of the writing process. The result is a marked loss of freedom and fluency. The movement is usually lowered; often it is a drawn movement. The speed is slow marked with hesitation, pen lifts, and pen pauses.

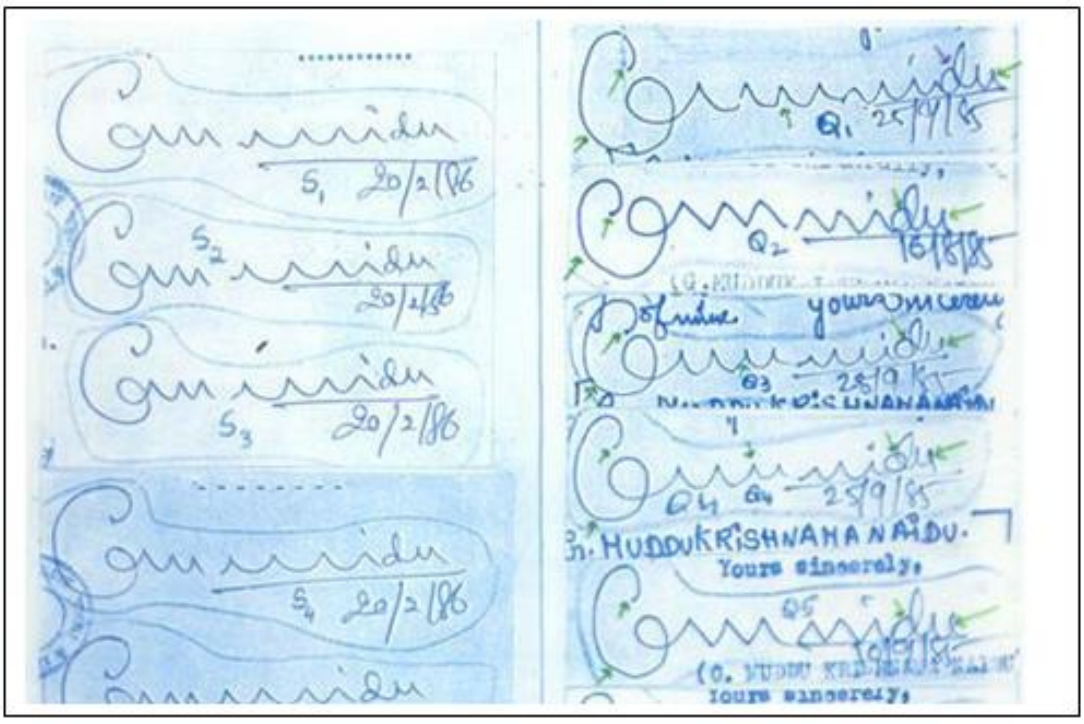
In copying a signature, a forger's attention is frequently shifted to the model signature and back to the writing of signature. This alternation of attention results in unnecessary pen lifts or pen stops, which are usually inconsistent with the skill of the model signature and are likely to occur at unnatural places. In an attempt to write continuously the forger may delay the shifting of his attention to the model and, then, he may miss a natural and habitual pen lift occurring in the model signature. More pen lifts are usually expected in a simulated signature. They may be more or less depending on whether the alternation of attention is quick or delayed. Pen lifts or pen stops at unnatural places and absence of pen lifts at habitual places are indicative of simulating process.

The reason for his belief in and insistence on close resemblance is firstly his fear that variation or divergence from the model may make the signature liable to suspicion. Secondly, natural variation is hard to understand and harder still to simulate. This makes him pay all possible attention to every perceptible detail. The result is an unusually close resemblance with the model signature.

A forger seldom contains his anxiety. He himself is the severest critic of the signature he forges. He is scarcely satisfied with the signature as first produced and therefore tries to perfect it by correcting what he considers defects by careful retouching, over writings or patch-ups. These retouching etc. are necessarily minute and hidden, for a forger detests obvious retouching and correcting lest they should draw attention and create suspicion.

3.5.1 SIMULATED FORGERY

A simulated forgery is a simulation or imitation of a genuine signature / writing. In this method usually the forgerer will have a model before him and would try to copy the design of the letters and other broad features depending upon his skill, practice and competency. (Fig .4.)



Standard signature Disputed signature

Sometimes he may not have the actual model signature before him, but may forge the signature from a mental picture of a genuine signature. It is also called as freehand forgery or simulation by memory which term does not, however, mean freedom of hand as in the case of normal/genuine writing; it is so called because the hand is not guided any outline as in the case of traced forgery. Practically it is not possible to adopt each and every writing habit of another person and to avoid one's own writing habits to interact in the process of forgery. The forger is likely to fail both these attempts. Such forgeries are usually the combination of the normal handwriting of the forger and letters bearing some resemblance with the signature(s) or writings of the actual writer. The degree of resemblance, of course, depends upon the ability of the forger to memorize and reproduce the letter forms.

Such type of forgeries can be easily detected and proved because forgery by memory is a primitive type of forgery and no forger can memorize or reproduce all the features of the signature or writing to be forged.

The process of copying from a model signature or writing is a conscious act and it always tends to produce unnaturalness, slow and drawn movement and defects in the execution of strokes such as hesitations, unusual breaks/pen lifts, careful joining, retouching etc. Inconsistency is also likely to be formed in respect of speed, pressure etc. In any writing made with conscious attention to the writing process the finger become rigid with increased grip pressure because unless the forgerer tightens his grip of pen he cannot hope to move it in an intended direction.

Disputed Signatures showing superior skill; an evidence of fraud:

It has been experimentally proved that a writer with a lower writing movement cannot ascend to higher writing movement i.e. a writer who is able to write with finger movement cannot write with hand or forearm movement unless he improves his writing skill with the passage of time.

In copied forgeries, it sometimes happens that the forged signature(s) or writing show better writing skill and penmanship than the genuine signature(s) or writing. The reason being that, when the forger possesses better writing skill than that of the person whose signature is to be forged, he may write letters in a skilled manner without thinking that such a skill is beyond the capability of the author of genuine signature. If the disputed signature displays better penmanship than the genuine/normal signature(s), it conclusively establishes that the disputed signature is a downright forgery.

If the signature in dispute is written with greater speed and the writer of genuine signature(s) is not capable of writing with such a speed, it is a strong corroborative factor to conclude that the disputed signature is a forged signature.

A forged signature may not also closely resemble the genuine signatures when the model signature is of a different style as compared to the standard signatures on hand. In such a case it may be necessary to have standard signatures of similar style in order to prove the forgery conclusively though its physical quality often reveals the mental background and speaks for its fraudulent character.

Simulation of tremors is difficult:

When an attempt is made to simulate the signatures or writing showing tremors of old age, illness, or illiteracy, generally the forger is not able to reproduce such tremors in the forgery. To copy or imitate natural tremors is not an easy task because a forger cannot acquire and match muscular weakness resulting from natural causes in an artificial manner.

The tremors in forgery being unnatural do not show uniformity i.e. some of the strokes are too strong and fluent whereas some others show hesitations and wrongly placed tremors. Sometimes the forged signatures purporting to be written by an old person show even minute retouching and over writings.

To study the quality of the strokes, hesitations, pen lifts/breaks, pen pauses, additions, careful joining etc. the use of stereoscopic microscope is essential.

3.5.2 TRACED FORGERY

A traced forgery as the name implies is the result of an attempt to transfer to a fraudulent document an exact facsimile of a genuine writing by some tracing process.

Traced forgeries usually shows hesitation, abnormal changes of direction, inconsistent pen pressure, and unnatural movement interruptions in a more pronounced manner than simulation, but this again depends upon the specific process of tracing employed and the skill of the operator. Usually the forger's main efforts are to make the forged signature similar to the model signature for this he considered tracing to be the best technique among other techniques of forgery.

Traced forgeries normally shows drawn movement, hesitations, unnatural pen lifts, defective shading, minute retouching and over writings, blunt commencement and terminals.

In many important cases the model for a traced signature is actually put in the case by the claimant in order to prove the forged writing to be genuine. The reason for this surprising action seems to be the thought that the genuine writing so like the disputed signature will undoubtedly prove the disputed signature to be genuine.

To prove that a particular forged signature is a traced forgery:

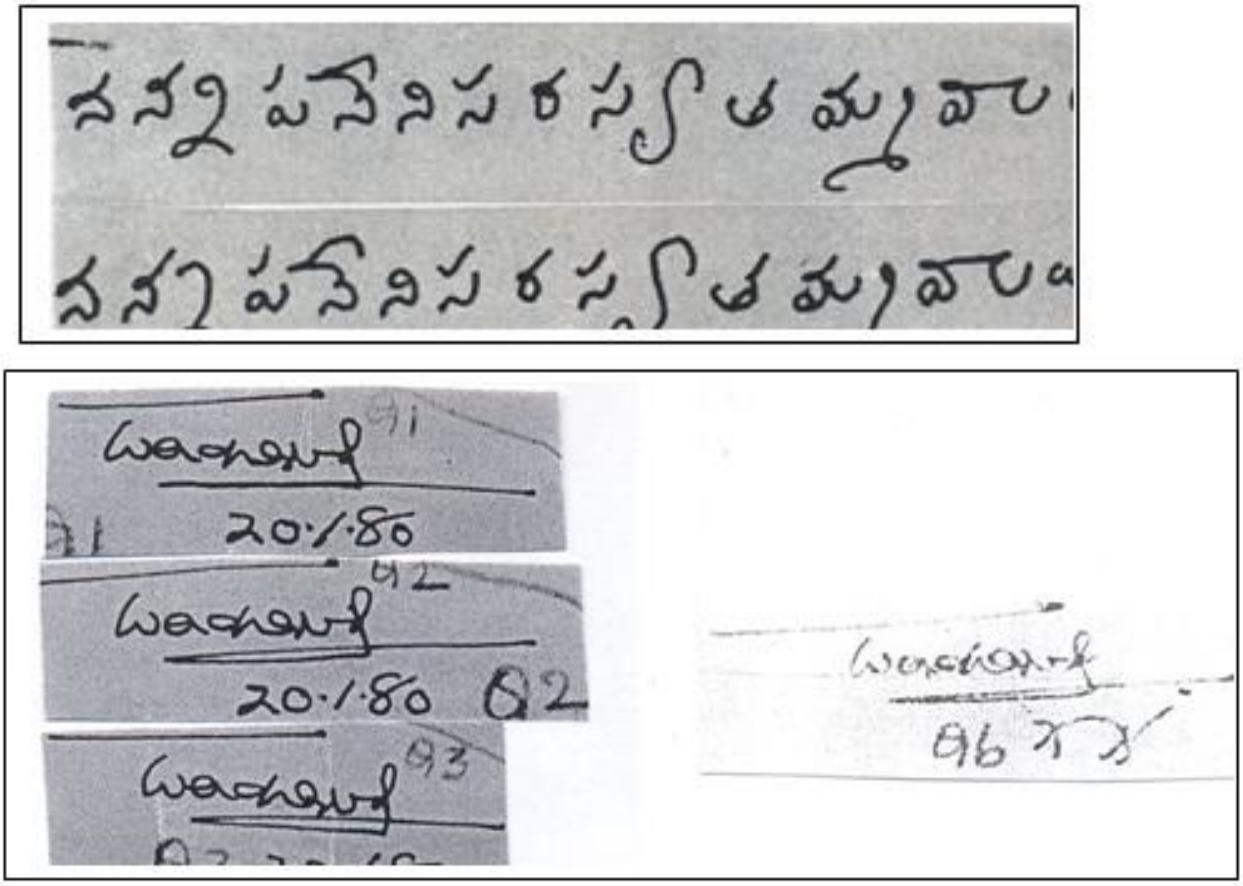
A traced forgery will probably be defective in one or more of the following particulars:

- Natural movement, freedom and speed of writing;
- Quality of line or stroke;
- Pen-lifts, retouching and shading;
- Selection and date of model writing;
- Pencil or carbon outlines or indentations pointing to a tracing process;

Pictorial identity of the writing with a genuine model or close, suspicious similarity of two or more disputed signatures and in some cases signatures in exactly the same position on a printed form also suggests that it is a traced forgery.

If two signatures coincide sufficiently, then one of them or both of them must be traced

forgeries and there is no exception to this fundamental principle.



Cases are brought to light wherein there are a number of disputed signatures which are superimposed one over the other from the beginning to the end. And, in such cases, even if a genuine signature or the model is not available, it can be proved conclusively that the signatures on all the disputed documents are companion forgeries. Here also photos on transparencies or on dia-positives will render considerable assistance to the expert.

Natural, free, unconscious, writing cannot be produced by tracing process. It is almost impossible by tracing method successfully to imitate natural tremor.

The methods of tracing commonly employed are:

1. Direct tracing: In this method the model signature is directly traced. The document on which the signature is required to be forged is placed over the genuine signature and then both the documents are placed against a light source so that the outline of the genuine signature is seen through to enable its tracing on the document. For this purpose, the documents are held against a door glass or window glass or since this position does not provide a proper rest for hand for tracing, a photographer's retouching desk or a transmitted light box (a box with a glass top lighted from inside) may be used. When the signature is thus traced directly, no extraneous outlines suggestive of tracing are found in the forged signature.

Sometimes, in direct tracing, when the model signature is not properly visible due to feeble light or when the forger apprehends sharp deviations due to his inability to follow the outline, he may put some guide dots as a precaution against possible departures from the outline and thus ensure correct tracing of the outline. Or it may be that he wants some deviation without sacrificing the much desired form resemblance. In any case, the

number of dots which he may put depends very much on his intention and confidence in achieving the desired result.

If a guideline is allowed to remain associated with the forgery, the discovery of its presence will be sufficient to expose it as fraudulent. If attempts are made to erase a guideline, it will be found very difficult to affect a thorough erasure, and in any event, the surface of the paper in the neighborhood of the forgery will be disturbed and so be likely to arouse suspicion.

2. Projection Tracing: Another method which also does not leave any extraneous outlines is projection tracing.

By far the simplest way of projecting an outline of a genuine signature on to the document to be forged, is to place the genuine signature over the place where the forgery is to appear, and then to pencil along its outline so heavily that a groove appears on the under sheet. This groove can then be conveniently inked-in.

3. Use of Carbon paper: A carbon paper is used to produce the outline which is inked. The carbon outline being somewhat greasy is likely to repulse the ink and consequently the inking may not be consistent throughout to obviate this, the inking should be heavy, else it may necessitate careful retouching or patch up.

4. Pencil guidelines: A sheet of transparent paper, such as tracing paper, or even paper which is highly translucent such as grease-proof paper, is placed over the genuine signature and pressed into close contact so that it shows through quite clearly. The signature is then copied on to the tracing paper with soft pencil or ink. If gentle pressure is employed, there will be no indication that the genuine signature has been used as the basis of a tracing.

The only disadvantage of a tracing made in this manner is that it is twice removed from the original, and considerable care has to be taken at all stages if all the details in the genuine signature are to be reproduced in the forgery.

5. Facsimile outline of indentation: The genuine signature is placed over the document and then the signature is traced by a pointed metal or plastic rod with sufficient pressure to produce an indented outline on the document below. The indented outline thus caused is carefully inked.

Demonstration of traced Forgeries: The science of hand writing comparison is a demonstrative science. Until and unless the observations cannot be properly demonstrated in such a manner that a common observer may be able to follow them.

If the traced forgeries are demonstrated in a proper manner then there may not be any need to corroborate the findings and explain the facts.

1. Stereoscopic examination: The examination under stereoscopic microscope reveals the most common symptoms of traced forgery i.e. defective line quality, i.e. hesitation, unnatural pen lifts, defective shading and minute retouching etc.

2. Direct superimposition of original signatures: The superimposition of traced and model signatures by transmitted light is a useful method for demonstrating overlapping strokes. However, in some cases, due to thickness of paper(s) or the presence of writings on its reverse, this method may not be practicable and also, if two or more traced signatures are present on the same paper, then it may not be possible to superimpose them inter-se.

3. Making dia-positives or transparencies: The dia-positives of the traced signature

and the model signature or comparison signatures are prepared by photographing them with dia-positive film on the same scale and the dia-positives so formed are superimposed to show the coinciding strokes.

4. Placing signatures under ruled squares: This method of demonstrating suspicious similarity in the traced and model signature is considered to be the most effective method. The signatures are placed under a glass; celluloid or any other transparent sheet bearing ruled squares and they are photographed on the same scale. This method has basic advantage over the other methods that the suspicious line quality defects such as pen lifts, suspicious hesitations, retouching, etc, can be observed and illustrated an enlarged photographs and the identity in size and proportions of the corresponding strokes and divergences can be seen clearly.

5. Making composite photographs by superimposing negatives in the enlarger: In this method, the traced and model signature are photographed on the same scale and the negatives are superimposed in the enlarger to make a composite print.

Characteristics in a traced forgery are not incidental to any habitual movement and there is no question of natural variation.

Superior penmanship in a questioned signature cannot be determined without a comparison with the standards.

When the questioned signature is declared as a forgery the next question asked is, who forged it. In many cases this question cannot be answered for the simple reason that the forger is unlikely to introduce his own characteristics into the forged signature. Even if he introduces any, it is doubtful that they are adequate to reveal his individuality. A traced forgery is a drawing rather than writing and it is a rigid following of an outline and as such there is little likelihood of any of the forger's writing characteristics entering into it.

The forger may write in his own way one or two letters when their outline is not properly visible due to opacity (say, due to revenue stamps across which the forger is required to make the signature). But such meager material would not normally reveal his identity. The difficulty in identifying a forger is that simulation and tracing, both being double operations as stated before, afford an effective disguise. It is only when a forger resorts to free and rapid simulation, when he is forging from a mental model, when he is not actually simulating or when the signatures or writings are adequate in quantity he may incorporate some of his own peculiar characteristics which may make it possible to identify him.

It is an interesting phenomenon that a person cannot write his signatures twice exactly alike and genuine signatures vary from each other, to some, greater or lesser extent depending upon the internal and external circumstances, writing skill and taste of the writer.

However while applying superimposition test it should also be kept in mind that even a traced forgery cannot mathematically be the exact reproduction of the model signature and there may occur some departures in the strokes from the model signature due to:

- lack of ability of the forger to clearly follow the lines;

- dim lines of the model signature;
- accidental change in the position of model signature due to the movement of the paper
- nervousness of the forger etc.

In such cases, the deviated strokes invariably return to the common track especially at prominent key points.

3.5.3 FREEHAND FORGERY

Forgery without model or forgery by impersonation:

When a person merely writes/signs the name of another person in his own handwriting in normal manner or in some modified manner, representing himself to be that person with some ulterior motive, such signature is a forgery.

In this type of forgery, no attempt is made to simulate or trace from a model signature and once the genuine signatures of the actual person are available, the forgery is obvious and to prove the same is not difficult Fig 6.

Fig. 6: Freehand Forgery

Fig. 6: Freehand Forgery by impersonation

3.5.4 TRANSPLANTING REVENUE STAMPS BEARING GENUINE SIGNATURE

A genuine signature is utilized by transplantation of revenue stamps containing a genuine signature. The stamps with a genuine signature are removed from some other document and affixed to the desired document. The evidentiary facts help to detect such fraudulent transplantation of revenue stamps because in this case the question of

sequence does not arise, nor is there the problem of adjusting the matter above the signature.

The stamps lifted from some other genuine document may or may not contain the complete signature. Where the stamps do not contain the complete signature, the missing letters in the beginning or at the end or at both places are carefully added after the stamps are affixed to the fabricated document. In such a case the signature is partly genuine and partly simulated. Fig.7.

Fig. 7: Transplantation

Whatever be the reasons for the utilization of a part of the genuine signature, it is done in practice. Evidence of transplantation of stamps is proved by:

1. Difference in the shade of writing outside the stamps and the shade of the ink of writing on the stamps.
2. Difference in the nibs used for these two writings. The nature of strokes and curves should be carefully observed.

3. Any difference in the handwriting characteristics between these two writings.

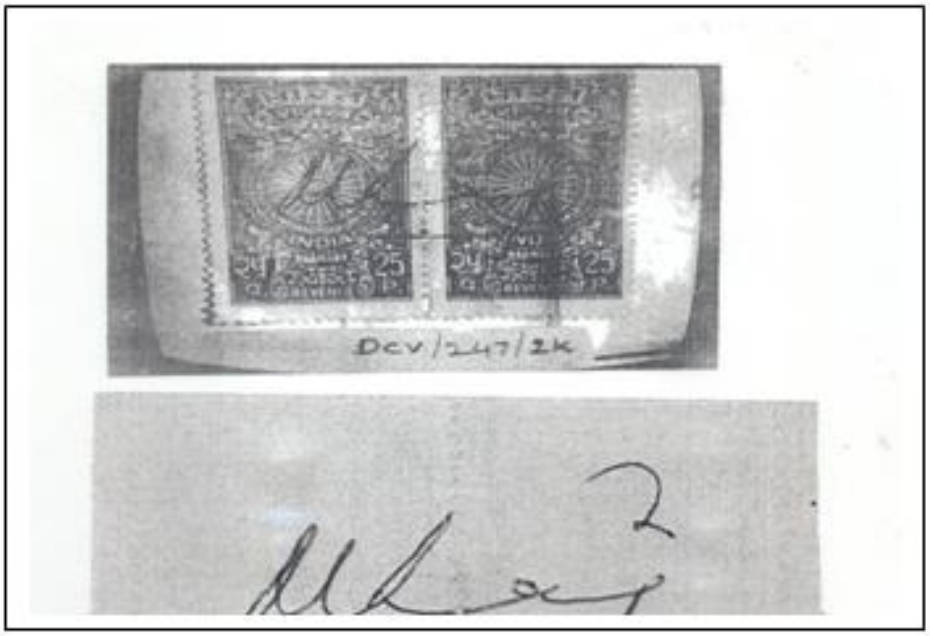
4. An unnatural slow writing outside the stamps while the writing on the stamps is free and fast.

5. Any overwriting of letters on the stamps suggesting an intention to bring in similarity of a shade of ink.
6. Non-continuity of writing at the points where the writing goes from the paper over to the stamps and from stamps to the paper.
7. The ink of the strokes which cross the perforations of undetached or contiguous stamps normally runs through the perforation hole to the paper below. The absence of ink on the paper below showing up an obvious break in the strokes suggests the lifting of stamps from some other document and reaffixing to this document. Fig. 7(a).
8. Adherence of extraneous paper fibers or layers either on the edges or below the stamps.. If such a layer shows a rule or traces of writing it will be a positive indication

that the layer has come off with the stamp when removed from the original document. Fig. 7(a).

9. Excess gum deposits.

10. Any extraneous ink strokes on the edges of the stamps which could be broken parts of some writing and which show broken ends at the perforation edges.



The evidence of transplantation would be prominently seen under transmitted light. A photo enlargement taken under transmitted light would clearly show it up. It is however important to bear in mind that sometimes a short signature is made on single revenue stamp so that no stroke of it touches or crosses the perforation edge. Where two or more stamps are used the signature is made sometimes in such a manner that letters are distributed stamp wise and no stroke crosses the perforations. If the stamps containing such signatures are removed from the genuine document and affixed to the fraudulent document, there may not be any evidence of transplantation of stamps. It is therefore always advisable to make the signature across the stamp or stamps so that some strokes or curves cross the perforation edges. For this and other reasons, the practice of signing both on stamps and below the stamps on the plain surface of the document is coming into vogue.

It is of utmost importance to interpret the evidential factors with care and caution. Not infrequently we find that the ink of a stroke of a genuine signature crossing a perforation hole does not run into it. It is likely to happen in the case of fine writings made with light pressure and fast speed. One is liable to misunderstand such conditions if he does not carefully consider the other facts in the document and weigh them properly.

3.5.5 UTILIZING A GENUINE SIGNATURE (BUILT-UP DOCUMENT)

Genuine signatures are often utilized to prepare fraudulent documents. Signatures on such documents are naturally questioned by the alleged signatories and if the enquiry is limited only to signatures the probable consequence is a gross miscarriage of justice. The examiner should therefore look to all the facts in the document even if the point of

reference relates only to the signature. There are persons who do not wish all the facts about the document to be brought to light and they raise all objections to examining anything other than the signature. But if the interests of justice are really to be served the examination must be thorough and exhaustive.

It is also likely that the expert, if he does not go beyond the question of the signature, may be blamed for not having observed all the relevant facts which throw light on the nature of the document.

Osborn states*:*

"The denial of the signature means (or should be taken to mean) a denial of the execution of the document. The party questioning his signature often is confused and placed in a dilemma as to the genuineness or otherwise of his signature though he may be certain that he has not executed the document. His failure to question the entire document in specific terms or to specify the fraudulent nature of the document should not be an excuse for limiting the enquiry only to the signature or for restraining the expert from looking into the other aspects of the document. As a matter of fact the party is not qualified to pin point the fraud or describe it; it is the business of the expert".

Genuine signatures are utilized in a number of ways. A common practice is to give signatures on blank papers. Under certain circumstances, some persons sign on blank papers in full confidence believing that they would be used only for the intended purpose. It is not uncommon that such signatures are used for preparing fraudulent documents with a motive for wrongful gain. Later when the signatory is confronted with the document, which he did not sign with a knowledge of the contents, he emphatically denies having signed the document. The signature being undoubtedly genuine his denial will not carry conviction unless and until it is proved that the signature, though genuine, pre-exists the body writing and the document as such is not genuine Fig. below.

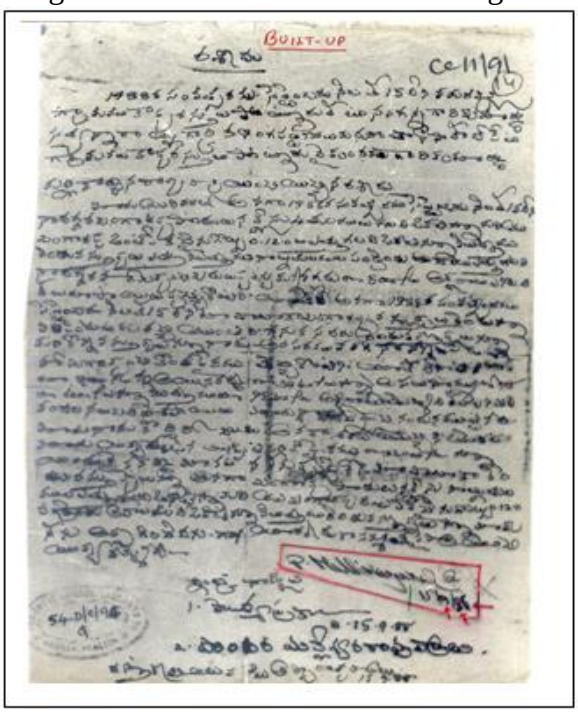


Fig. 8: Built-up Document

The fraudulent utilization of a genuine signature usually leaves its tell-tale signs in the document. The forger will have, in addition to his usual fear-anxiety complex, an acute space consciousness and he is also conscious of the pre-existing signature which shows up in the nature of the placement of body writing above the signature. He has a

compelling necessity to adjust the body writing in the available space which may be too large or too small and he often fails to correctly estimate the various factors, the extent of body writing, the likely space it may normally occupy and the degree of change in the size and spacing necessary for judiciously covering the blank space above the signature. As a result the body writing shows inconsistency in respect of margins, inter-word spacing, interline spacing and the size of letters. Generally there would be a far too wide spacing in the beginning with gradual cramping of lines as the signature is approached or the reverse condition may happen. Alternate wide spacing and narrow spacing may be found. The size of the letters may also vary with the varying space.

As the writing approaches the signature the writer becomes acutely conscious of the signature and if there be some more matter to be written it impels him to change the alignment and make the line ascendant and in some cases avoid crossing the signature by curving up the line of writing. The avoidance of the signature is a sure indication of the existence of the signature prior to the body writing.

Sequence of strokes

In an enquiry of this kind the question is, which is written first, the body writing or the signature. Positive evidence of their sequence is often provided by crossing lines (of body writing and signature) or by a fold in the paper running across body writing as well as the signature. The sequence of the crossing lines is determined by the nature of strokes at the crossing, which is governed by many factors. The crossing may be of (1) two fluid ink lines, (2) two ball point strokes, (3) two pencil strokes, (4) two felt pen strokes, (5) a stroke of any of these four types with another type of stroke or rubber stamp impression or thumb impression or typewriting. In any case a careful observation under magnification and under illumination from different directions and different angles will often reveal the sequence.

When two fluid ink lines cross each other the physical condition of the crossing depends on:

- The kind of pen used,
- The movement employed,
- The speed of writing,
- The kind and colour of ink,
- The character and condition of paper,
- The time elapsed between the writing of the two strokes,
- The use of blotter on one or both the strokes,
- The degree of pressure with which the strokes are made,
- The direction of individual strokes as well as the relative direction of the strokes, and
- The amount of ink flow.

It should be borne in mind that the heavier stroke always appears to be above the lighter stroke whether or not it is the fact and that a mere appearance therefore is no guide for determining the sequence. The sequence of ink strokes is reliably known by the running

of the ink of one stroke into another and the continuity of edges or ink film or indentation of the strokes. The paper fibers are disturbed and become loose by the absorption of the ink of the first line and therefore the paper at the crossing would be more receptive to the ink of the second stroke which results in the running of ink into the previous line. When the strokes are made with a felt pen it may sometimes happen that the ink of the first stroke is carried into the second. This condition is normally distinguishable from the running of ink of the second stroke into the first. However, the three important factors, the distinctly continuous ink film, the continuity of edges and the continuity of indentation or track should always be considered.

When pencil strokes are involved the sequence is determinable by the continuity of the striations caused by wearing off of lead particles or the presence of graphite particles under or over the ink film. If a carbon stroke and an ink stroke cross each other the carbon particles could be seen to lie either under or over the ink film. The problem of sequence of writing and stamp impression or writing and a thumb impression or handwriting and typewriting is somewhat different and more difficult. Although in a number of cases it is possible to determine their sequence, it requires a cautious approach. Evidence of sequence in any case must be observable and demonstrable. The question of sequence also arises out of additions and interpolations. In many cases it is of a crucial nature. It may not be possible to determine the sequence in all cases, but where it is determinable it offers unassailable proof.

The sequence of two ink writings cannot possibly be determined by their relative ages because the age of the ink cannot be determined accurately by any means. Even the age of iron ink (blue black ink) which undergoes chemical changes with the passage of time can only be broadly estimated but not accurately determined because the rate of change in the ink is influenced by a number of factors. They do not affect the ink uniformly in all cases nor do we have any control over them.

It is possible to determine the sequence of the body writing and signature from the nature of the ink strokes crossing a common vertical fold in the paper. When the paper is folded its fibers at the fold are stretched out on one side and compressed on the other; and the sizing is disturbed. The degree of the disturbance of the fibers and the sizing depends on the kind of paper, the pressure applied on the fold and on how many times the paper is folded and unfolded. In the case of a heavy fold the surface may show up a crack or with some kind of papers a ridge may form along the fold. When an ink stroke crosses a fold the ink is likely to run into the fold, and when a stroke crosses a ridge, the ink stroke shows thickening on one side and hiatus on the other side. On the contrary if the fold is subsequent to the writing, the ink stroke tends to break at the fold and its edges are always clear cut as opposed to the spreading of the ink of the stroke made after the fold. In a number of cases where a genuine signature on a blank paper is utilized, a common vertical fold occurs on the body writing and signature and it offers a clear evidence of their sequence.

Another method of utilizing a genuine signature is to tear off that part of a document containing the genuine signature with some blank space above it. The fresh matter is usually written in the blank space above the signature. Sometimes when there is hardly any space above the signature to accommodate the complete matter the text is begun on the reverse side (if it be blank) and completed just above the signature. Almost all the fraudulent documents of this type present odd features which go to prove their

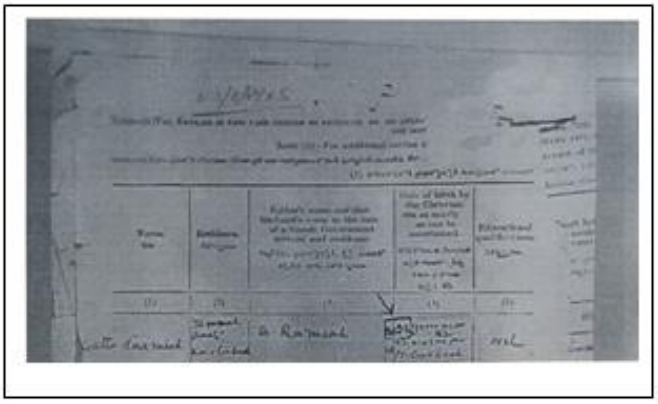
fraudulent nature beyond doubt. Firstly the size is invariably small, many times odd and suspicious features in the placement of body writing may also be present. The position of the signature in relation to the body writing, the edges and any extraneous strokes of previous writing remaining at the torn edges, may also throw light on their true nature. The inks used for the signature and the body writing may also provide some evidence. For instance, if the inks are similar and if the body writing shows feathering of ink while the signature does not, it is a suspicious circumstance.

Consideration of the available blank space and the extent of writing to be made sometimes necessitate erasing the previous writing instead of tearing it off. The previous writing may be erased either mechanically or chemically.

In majority of the cases by means of above types of studies, it would be possible to arrive at a conclusion whether the questioned writing written by suspect or not and to detect the forgery.

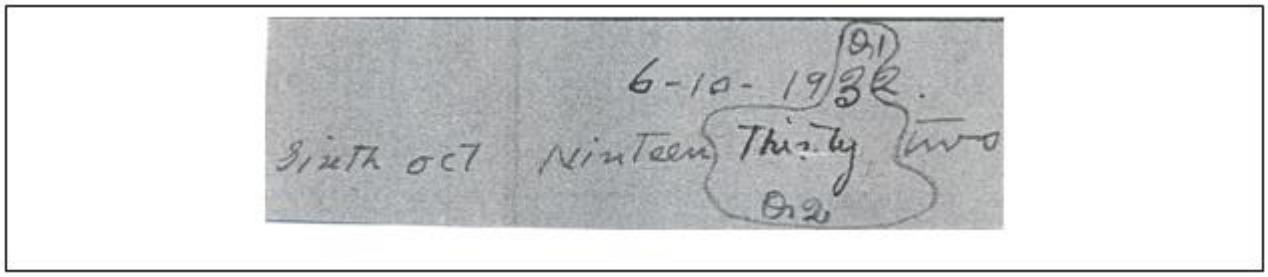
Different Types of Alterations and their detection:

- By the addition of some strokes to the existing strokes.
- The contents may be altered by first erasing the previous matter and then writing the desired one. Such an alteration is detected by examining the document for erasures.
- Alteration is also made particularly of digits of dates and amounts by carefully overwriting or interpolation.
- Often the preceding and the following digits are also overwritten besides the altered digit to bring in similar appearance of the shade of ink. Such an alteration is usually revealed under high magnification under transmitted and reflected light.
- Alteration by interpolation shows unnatural spacing and many times difference in the shade of ink. (Fig 10). Examination under ultraviolet rays and infra red rays is of great help in such matters.

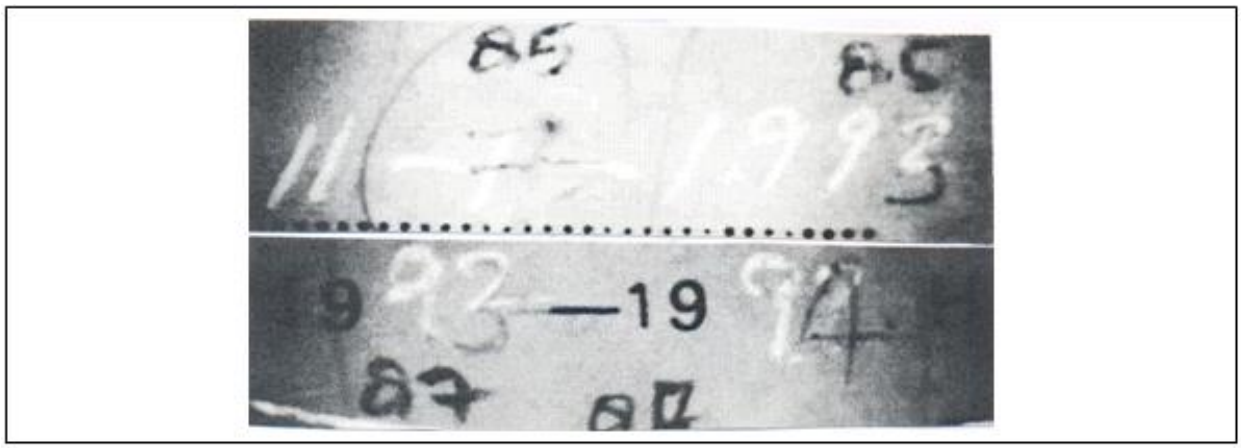


is altered as 25

Alterations in the service Register – Date of birth



Numeral 2 is altered as 3 and Twenty is altered as Thirty



Alterations in the Bonafide Certificate

Fig. 9: Alterations to the existing numerals and additions

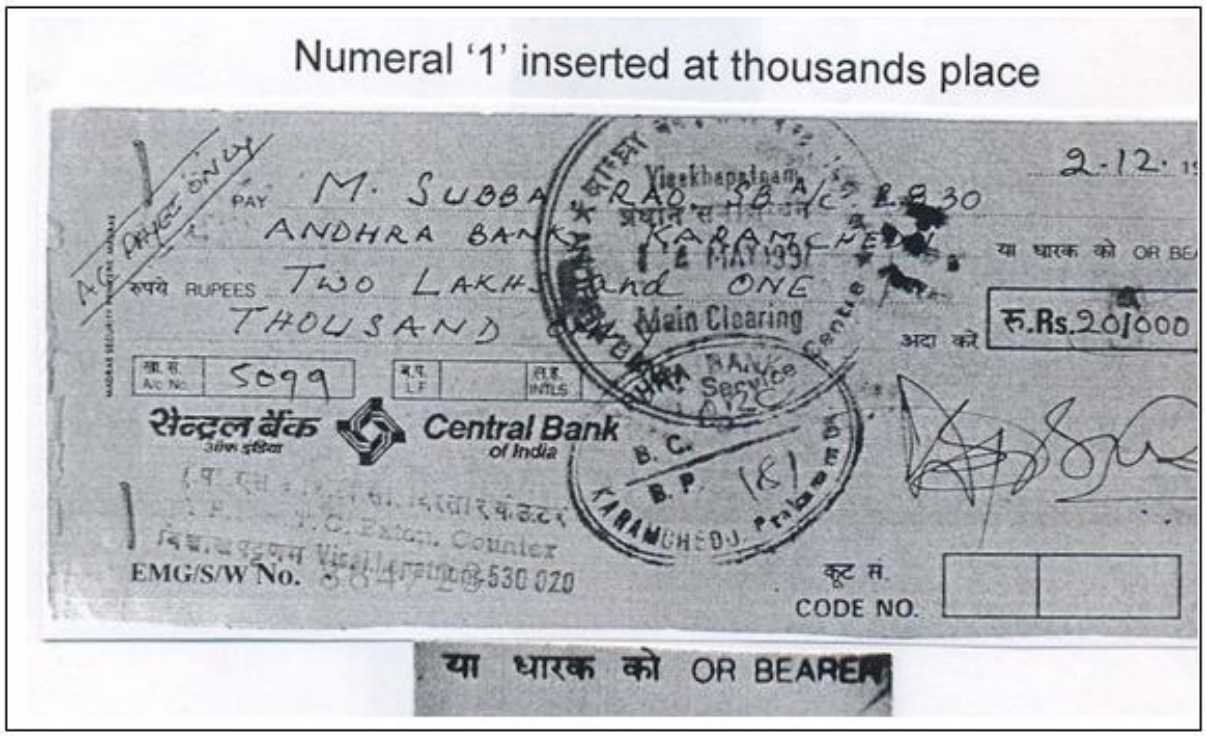


Fig. 10: Alteration by interpolation

Sometimes an entire sheet from a multi-sheeted book is removed or a sheet from a multi- sheeted document is substituted. In these cases it is necessary to examine the paper and the ink in addition to other evidence in the book or document.

The following are some important points to be considered.

1. Whether the sheet is of the same type as of the previous and following sheets.

2. Whether the size is matching with the size of the preceding and following sheets.

3. Whether its tint is similar to the tint of the preceding and following sheets.

4. Looseness or disturbance of binding.

5. Whether binding or stapling or pinning is original.

6. Page numbers

7. Indentations on the following pages

8. Continuity of the writing matter.

This included the consideration of

(a) The presence of erasures at the end of the previous sheet and at the beginning of the next sheet.

(b) Addition of linking phrases.

(c) Identity of handwriting.

(d) The writing instrument used: The question is whether the entire writing on the document is made with the same pen or different pens. It is reasonable to assume that the work of different pens would be different and hence writings made by different pens are distinguishable. But it is often difficult to distinguish writings made by two different pens. The factors in a writing which throw light on this point are: (I) the width of strokes, (ii) the separation of the two nibs, (iii) the character of the strokes such as smoothness, roughness or scratchiness, (iv) shading on strokes at right angles or on back strokes indicating the width of the nib point, (v) the nature of ink flow, for example, initial ink failures and scratches suggest the use of a fountain pen. This happens particularly when the fountain pen is kept open for a while before starting the writing and the ink gets dried. A gradual depletion of ink and a retake of ink by dipping the pen in the ink indicate a dip pen. (vi) Fluid ink writing can be distinguished from ballpoint writing. The rotation of the ball makes its mark in the structure of the lines. These and other factors suggest only the kind of pen used and individualization of the writing instrument is almost not possible. It can however be shown in a number of cases that a given writing could not have been made by a specified pen. It is important to bear in

mind the limitations of this phase of examination of writings with a view to identify or distinguish the writing instrument.

(e) The ink used: The problem is two-fold. Whether the inks are the same or different and what their respective ages are. Inks are examined both physically and chemically. Ink strokes are examined under reflected and transmitted light (in good day light as well as artificial light) under different magnifications. They are also examined under ultra violet rays. Inks of different kinds are easily distinguished.

The similarity or difference in the shade etc., of the inks of two writings may indicate their continuity or lack of continuity. But it is scarcely possible to say the respective ages, though it is sometimes possible to say whether they could be contemporaneous or not.

Chemical tests mainly help to determine whether the inks are similar or different. Only in the case of iron inks, it is possible to have a rough estimation of the age by the nature and extent of 'running of ink' when water is applied. Even the physical examination of iron inks may enable to make a similar estimation of their ages. It is not advisable to undertake the chemical tests until the physical tests are completed and unless they are very essential. Genuine additions, interpolations and scorings made in an important document are usually mentioned and certified in the document itself. But such a note (or certification) itself may be an addition. These are also examined with reference to the ink, the writing instrument and the writer in addition to its relevancy and consistency with the main text.

Examination is made under different light sources to detect the tampering such as alterations/ additions/insertions and also in some instances to establish the authorship of the tampering.

3.6.2 ERASURES

Many questions of importance arise regarding alterations in documents and the questions are presented in a great variety of forms. It may only be necessary to determine whether a change or erasure has actually been made, or it may be a matter of great importance to show what was first written. Sometimes the whole inquiry is regarding the change in a single word, or even of one figure or part of a figure in a date or an amount, and again the question may arise whether a whole document, with the exception of the signature, was erased and a new and fraudulent document written above the genuine signature. Wills, notes, receipts, and other important documents have been manufactured in this way.

ERASURE means the removal of existing portion from the document. Erasures are of two types.

- Mechanical Erasures: (An abrasive erasure) In which the writing is effected by rubbing with rubber erasures or scratching out with a sharp instrument.
- Chemical erasures: In which the writing is removed or bleached by chemical agent. E.g. Liquid ink eradicators.

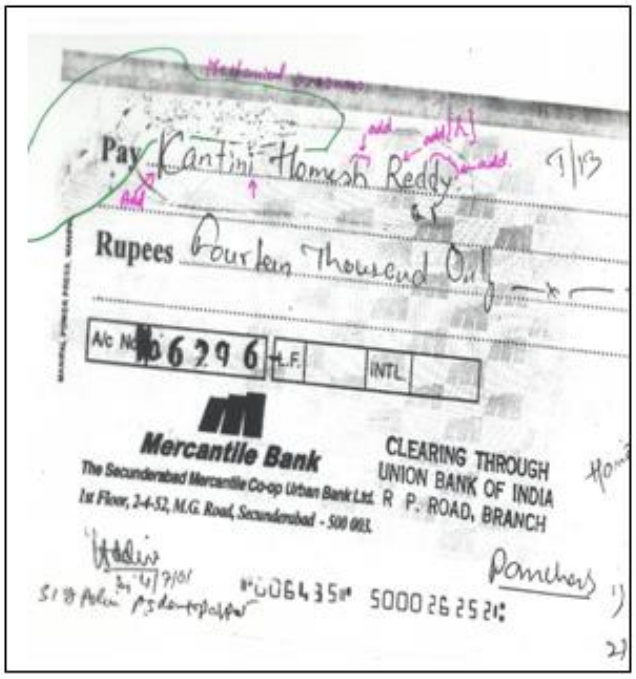
Mechanical Erasures:

Mechanical erasure involves abrasion of the surface of paper by the artist's gum or rubber eradicator or a knife / blade. Abrasion of surface not only takes away the writing but some part of the paper material. The loss of paper material is much less when soft rubber is used and much more when ink rubber or knife blade is used. If the abrasion is gentle there may not be a noticeable change in the transparency of the paper at the erased area, but if it is heavy there results a thinning of the paper giving increased transparency. It may even cause a hole in the paper depending on the amount of abrasion and the kind of paper. There will be a gradual thinning of the paper around such a hole and as such it is distinguishable from a punctured hole. In any case the sizing is affected and the paper fibers are disturbed. The whiteness of the paper is likely to be reduced. If the paper is ruled or having a tinted design / security print the erasing of writing on such a paper also takes away the rules or the tinted design / security print in that area. Fig. 11.

ORIGINAL CHEQUE

Erasures in the date portion: Original Date is deciphered as: 21/08/03

M E & TEXT ALTERATIONS Canfin Homes Ltd



Fibre disturbance at the erased portions Fig. 11: Mechanical Erasures

If a writing with ink crosses the field of an abrasion erasure, the resulting conditions will usually show very plainly that the writing followed the erasure. The operation of making the erasure so disturbs the paper that the paper is more porous and the ink makes a stroke at that point distinctly different from strokes on the other portions of the same sheet.

The line in the field of the erasure is to some extent wider and rougher than it otherwise would be and the ink runs out sidewise forming a series of minute points extending in both directions from the stroke, described as „feathering‰.

Writing over an erasure will sometimes shows through on the opposite side of the sheet.

The attempt is sometimes made to smooth or rub down the erasure before writing and if this is skillfully done on good paper the ink line at such point will show but little difference from a normal line until it is looked at under proper magnification. A microscopic examination of the paper will always show a distinct difference in the quality of the line over an erasure due to the disturbance of the fiber and the roughening of the surface of the paper.

The following are a few important steps for the examination of erasures:

1. Examination of the paper surface by reflected side light for disturbed sizing.
2. Examination of paper under transmitted light for increased transparency (thinning of paper) or any minute holes due to mechanical erasures.
3. Examination and comparison of several parts of the writing on the document.
4. Comparison of the ink shade.
5. Examination of the width and quality of lines.
6. Looking for discoloration or removal of tint or rules / security print.

In case of fluid inks, sometimes if the ink is penetrated deep into the paper the superficial layer though disturbed or taken away by abrasion, due to presence of

ingredients, it is possible to decipher the original writing by using different light sources.

Chemical Erasures:
Often writings are erased by applying chemicals which turned coloured compounds into colourless compounds. This chemical change is achieved either by oxidation or reduction; but oxidation is preferred because with reduction there is the risk of restoration of colour due to atmospheric re-oxidation. The use of chemical eradicators produces a stain in due course in addition to disturbing the sizing. They bleach not only the writing but also the rules or the tinted background or even the colour of the paper.

Writings made with washable inks are attempted to be removed by washing with a suitable solvent. It may help to remove the colouring matter and render the writing very faint. Washing effects the sizing loosens the paper fibers. There is also the likely-hood of the colouring matter running laterally.

Since in all types of erasures the sizing and the fibers of paper are disturbed, ink writing made over an erased area is likely to show the feathering of ink.

In the case of chemical erasures, fluorescence may be seen under ultraviolet rays if the inks contain fluorescent compounds. In the case of raised cheques and drafts, which contain background design, chemicals are applied carefully only on the strokes and curves taking care to avoid the design. When such raised cheques are examined under ultraviolet rays the erased writing would often fluoresce and a photograph taken under ultraviolet rays shows the erased as well as the fresh writing. Fig. 12.

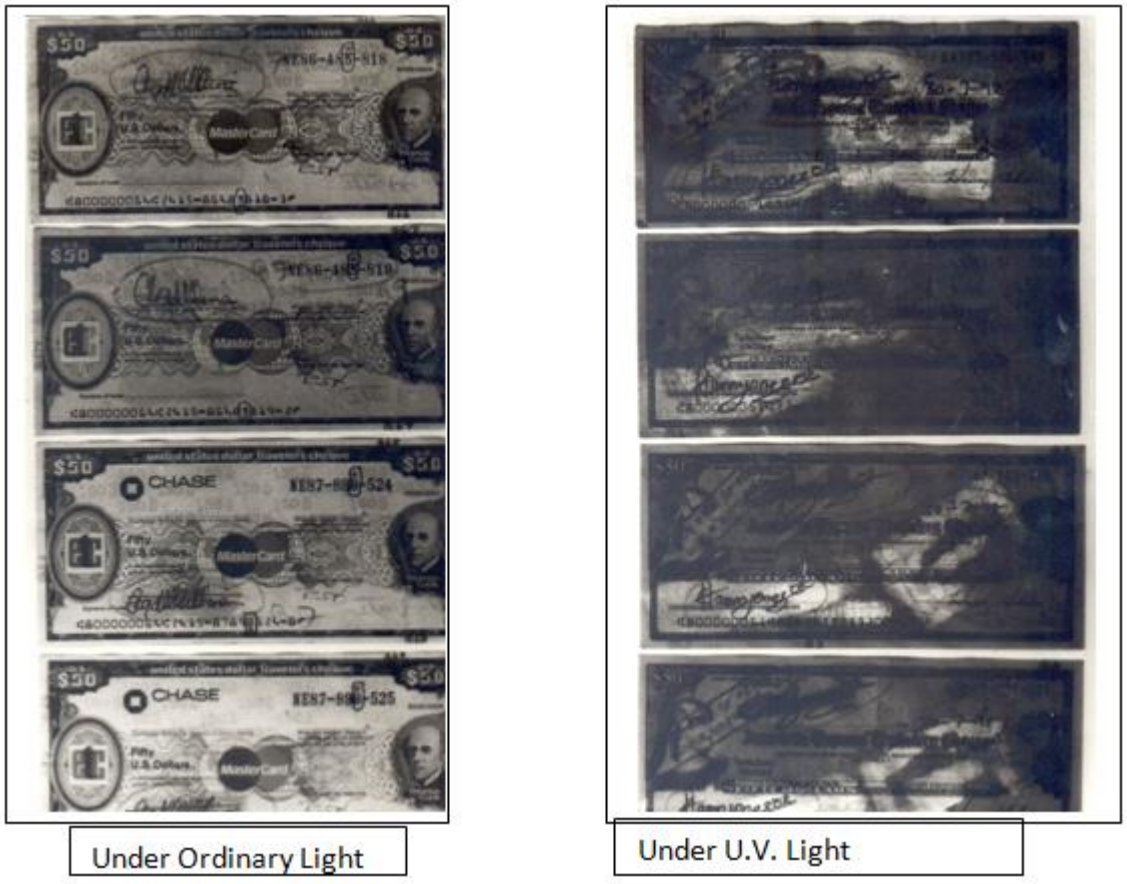


Fig. 12: Chemical Erasures

Some of the points to be observed in the suspected documents for erasures are:

- An examination of the whole paper surface by reflected light.
- Comparison of the line quality of the several parts of the amount in words and comparison of the line quality of name of payee and words of amount line.
- Examination of the serial number on the document in order to discover if it is made with rubber stamp or shows any irregularity.
- Comparison of exact tint and quality of ink in amount line with other parts.
- Comparison of width of pen lines or pen strokes of the various parts and search for any irregularities due to differences in sizing or surface of the paper on different parts of document.
- Search for discolorations due to chemical erasures.
- Examination of back of document in the field where suspected writing appears for evidence of embossing or erasures.
- Examination of style, slant, size and speed of writing of amount in words and figures compared with writing on other parts of document.
- Careful examination of amount in figures for evidences of lack of uniformity.
- Examination for odor of chlorine ink eradicator.
- Observation of amount line and amount in figures by transmitted light with sun shining directly on the document.

The important steps for the examination of chemical erasures are:

1. Examination of the back side of the paper for stains and indentations.

2. Spreading or running of ink due to wetting with solvents or chemicals – whether it is inconsistent with the shade and quality of ink strokes.

3. Examination under ultraviolet rays and infrared rays.

4. Photographing on panchromatic film with different filters; also under ultraviolet rays and infrared rays.

3.6.3 OBLITERATIONS:

Obliterations: To obliterate means to blot out so as not to be readily or clearly readable. Obliteration may be either intentional or unintentional.

Writings may be intentionally obliterated to render them indecipherable by covering or obscuring with markings, over writings, blots of ink or rubbing with pencil or carbon paper etc.

From time to time obliterations may be encounter in all types of documents. The anonymous letter writer may attempt to black out a printed written address on the only available envelop, and during war periods mail is censored in this manner. Successful decipherment or restoration depends principally upon the medium employed for the original writing and the covering material. If the original writing and the obliterating

matter differ in colours, then the use of colour filters may help to eliminate the colour of the covering matter and in the deciphering the original writing. If the ink of original writing differs in colour and/or opacity to infrared radiation from the pigments used to obliterate them by using IR radiation with the help of appropriate filters the original writings can be deciphered, the IR photography by using appropriate filter may decipher original writing.

Some times liquid white-out material is used painting it over the area to be removed especially with type writing, again new text can be written over the white-out. In both instances a careful inspection reveal the obliteration. The original material can be read by transmitted light or photographing of the back of the sheet with infrared sensitive film and filters. Even IR or visible light luminescence can be effective in determining what has been obliterated by correcting fluid as some inks may fluorescence and therefore be more easily visible. Occasionally the writings are obliterated by pasting paper over them. With the help of transmitted light (under VSC) the original writing can be deciphered. Fig. 13.

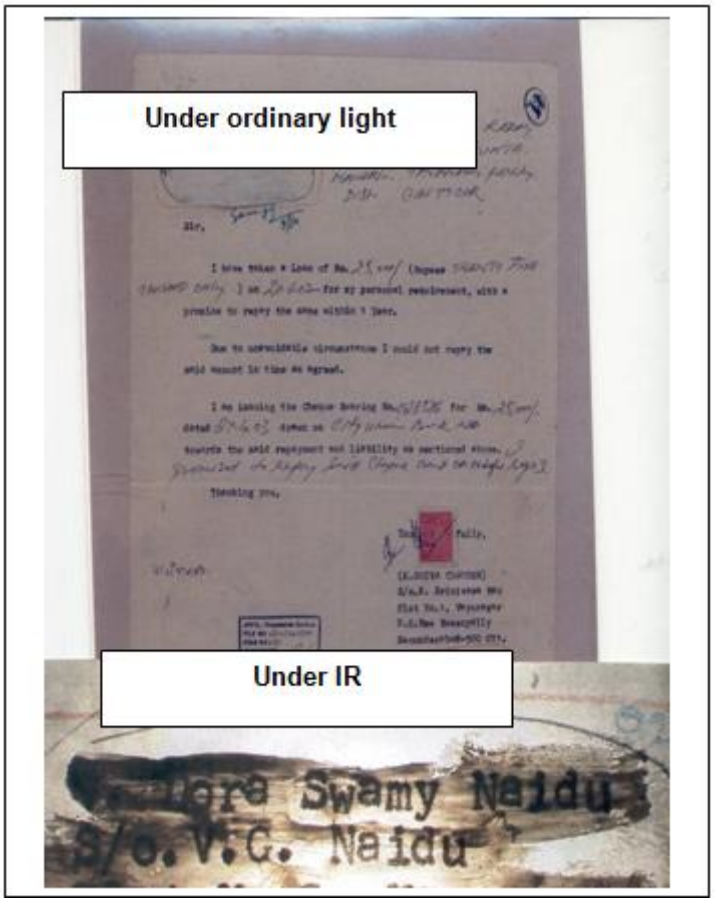


Fig. 13: Obliterations

3.6.4 INVISIBLE WRITINGS/SECRET WRITINGS

Writings which are not visible to the naked eye are called Invisible Writings / Secret Writings.

Simple substances like body secretions, medicines, fruit juice, milk etc. are used by persons who wish to hide their writings. These can be studied using U.V. and I.R.

radiation.

Invisible Inks: Inks which become visible after some treatment are known as invisible inks. Lemon Juice, Gum, Milk, Saliva, Onion Juice, Orange Juice and some chemicals like copper sulphate, Cobalt Nitrate, etc. may be used to write some writings which may appear invisible unless detected/developed by the application of heat, U.V. radiation or some chemicals.

Secret writing: Practically any colourless fluid which does not evaporate too readily may be used as a secret ink if there is no objection to the writing having a comparatively short life. The extreme example of this is distilled water; a writing in distilled water will affect the cellulose fibers and also the sizing which become wetted by it, so that even when the water has apparently dried off, those portions of the paper surface which have been wetted will differ from the remainder in the rate at which they will absorb iodine or other coloured substance from solution. If any non-volatile substance were dissolved in the water, this would have a more permanent effect on the power of the affected portions of the surface to absorb coloured material.

The simplest secret ink, a dilute aqueous solution of cobalt nitrate, dries on the paper as a very pale pink outline which is imperceptible if the paper is carefully chosen. On gentle heating, the pink hydrate loses water to form the intensely blue anhydrous salt and so the writing becomes visible. On damping the paper or simply by leaving it in a damp atmosphere, the pink hydrate is re-formed and the writing disappears.

The secret inks most favored by criminals are the body fluids such as saliva, urine and milk or vegetable juices from the lemon or onion. With exception of saliva all these char at temperatures at too low to darken paper a reaction which enables them to be developed. Writing in saliva cannot be developed by heating, but as one of the constitution of saliva catalyses the oxidation of iron gallotannate ink, when the sheet is brushed over with a very dilute solution of this ink, the secret writing is revealed as a dark line on a pale blue background.

By using different radiations by U.V., I.R. etc. the secret writings can be deciphered and photograph for record purpose. Fig . 14

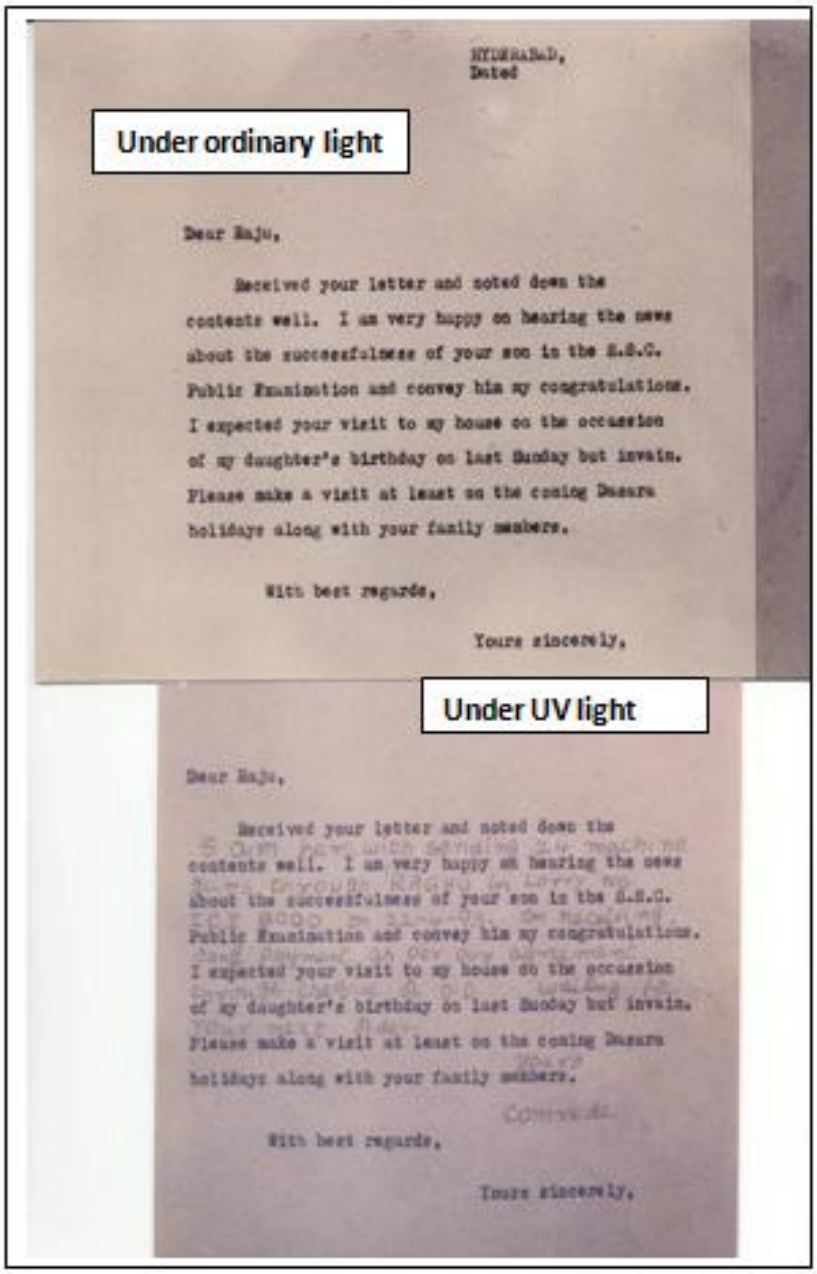


Fig. 14: Secret writings

Even sometimes the secret writings can be developed with the help of ESDA Note: Refer ESDA.

Dilute solutions of oil in alcohol or other solvent are sometimes employed as invisible inks, and hence form an exception to the rule that invisible inks are water solutions. When employed they entirely disappear in time by evaporation. Such inks may be developed by soaking the paper in water, when the writing becomes translucent and readily visible.

A solution of bismuth nitrate in dilute nitric acid, used as invisible ink, can also be developed by water. Both dilute nitric acid and dilute hydrochloric acid can also be used for secret writing and can be develop in the same way, the writing when wet becoming translucent and visible. Similarly sodium laryl sulphate can also be used as invisible ink

and can be developed in the same manner.

Treating with chemicals or heat should be avoided as they result in destruction of document.

3.6.5 INDENTED WRITINGS

The impressions caused on the underneath sheet due to the pressure applied on the instrument in the process of writing are called INDENTATIONS / INDENTED WRITINGS.

.The discovery of indented impressions can be of great significance. A letter written on a pad of writing paper may begin with the address of the writer, and the impressions of this will remain on the paper underneath. If that page is subsequently used to write an anonymous letter or a demand note it will carry on it an indication of its origin. Similarly, pieces of paper can be associated if impressions of one are found on the other. Impressions of a demand note may be detected on the pad on which it was written, thus providing proof of its source.

The best examples are: Fee receipts in colleges, universities; letter pads etc.

The indentations can be studied / developed by means of oblique light / ESDA / VSC.

Oblique light: The indentation produced by writers on an over line page can often be clearly seen. For best results in the developing the indented writing by visual examination are obtained by the use of the oblique lighting.

Illumination from a point source at a shallow angle will produce shadows in the depressions and render them visible. In most cases, some of the impressions are too weak to be read clearly, and some patience is required before all that can be read or identified. The light source is moved so that the angle of incidence is changed to show different parts of the indentations more clearly. The document can be photographed under the best lighting conditions to provide a record of the indentations, but because all the variations in the lighting conditions cannot be used in one exposure a photograph will not reproduce all that can be observed by actual examination. A curious feature of indentations photographed under oblique lighting conditions is that they sometimes appear in the photograph to be raised rather than depressed. Turning the photograph round one hundred and eighty degrees eliminates this optical illusion.
Although it is not always clear why the technique is on some occasions less successful than on others, certain findings indicate that it is likely that what is detected is caused by moving pressure applied to a paper surfaces in contact with another piece of paper. An exhausted ball-point pen, for instance, will make indentations but they will not be easily detected by the Electrostatic Detection Apparatus (ESDA), nor will impressions made on paper by writing over plastic where the indentations are made by plastic to paper contact. Although what is detected will remain for years, the method will not work once the document has been treated with a solvent. This makes it important to test for indented impressions before any treatment for finger prints is carried out. Similarly, wiping the surface of the paper with a piece of cloth will remove what is detected by the method.

Indented Writings

Indented impressions of type writings are occasionally found on documents which have been used as a backing between the paper being typed and the platen of the machine. These indentations are best detected by oblique lighting; electrostatic detection is rarely effective for this.

3.7 OTHER TYPES OF EXAMINATIONS

3.7.1 STAMP & SEAL IMPRESSIONS

Stamp/Seal impressions: Impressions made from the stamp/seal.

Seal impressions on postage stamps reveal information as to the place of posting the letter and date when it is posted. The office seal impression on a certificate from an authority may be fake one if it is a forged document. The facsimile signature stamp impression on a marks list could be a fake one. Stamp impression in a document when the signature is forgery is usually counterfeit in most of the cases.

To identify whether the disputed / questioned / suspected stamp/seal impression is genuine or not, it should be compared with the standard stamp / seal impression either by physical comparison or by superimposition technique.

By physical comparison by size and design of the stamp/seal; size and design of letters/emblem/any specific marks.

By super imposition techniques with the help of transmitted light or by preparing dia-positives.

i) Sample impressions should be collected from the stamps seized from the concerned/suspected person/office.
ii) If the disputed stamp/seal impressions are very old, contemporary period stamp/seal impression should be collected.

3.7.2 PAPER

Paper is a product consisting of a mat of cellulose fibres in compact sheets of uniform thickness.

One of the tasks of the forger is the finding of the suitable paper upon which the forged document is to be written. There are numerous ways in which the matter of paper becomes important in connection with the study of documents such as forged wills that have been written on paper made many years after the alleged dates of the documents etc.

The authenticity of the paper of a document may be questioned in numerous ways. E.g.

1) Whether the date of the document is in accordance with the date of its manufacture or the paper was manufactured after the alleged date written on document,

2) Whether a paper is identical with or different from the other papers of the same documents,

3) Whether the water mark of the paper is genuine or forged,

4) Whether the paper of the questioned receipt, agreement, compromise etc. is a part of some other paper from which it has been torn to use the signature or thumb impression appended thereon for some other purpose etc.

a. If the paper is torn from any paper the other piece of paper (b)If torn from any a book or a register the concerned book or register; (c) If foreign paper is substituted in any book or register the remaining pages of the book.

Manufacturing of paper:

Mr. Mitchell refers to the early period of manufacture of paper from 1799 to 1810 when machinery began to take the place of human hand. The procedure of making the paper was essentially the same as had been in use for centuries. Rags of linen or cotton were stored, cut up, washed with water and left to ferment in closed vessels for several weeks until a pulpy mass was obtained. This was beaten in oak vats with stamping rods fitted with iron heads and worked either with hand or by primitive mills. The pulp was then spread evenly upon wire moulds, upon which was then placed a mahogany frame termed the ‘deckle’ and subsequently transferred to a layer of felt. After being repeatedly pressed, it was sized and given final pressing.

In these days the paper is manufactured from a number of substances which can be classified into three groups.

1. Rag-linens, cotton, hemp etc.

2. Wood-Coniferous trees-pine, Fir etc. Deciduous trees - popular, birch etc.

3. Straw fibres-Esparto, rice, wheat oats, rye E. Grass etc.

The mechanical wood pulp and chemical pulps are bleached and soaked in water to

form suspension. The sizing an loading agents if any, are added to the suspension and it is poured onto a wire screen driven by rollers. The water drains out through the holes of wire screen and the fibres felt together. The paper is then dried by pressure, suction and heat and it is either milled to dress the surface or it is calendared to give a glossy finish.

To improve the quality of paper, some loading agents such as kaolin, resins or gums are added to the pulp or a coated paper is produced by spreading a mixture of kaolin and casein on the sheet.

Examination of paper: Laboratory investigation of a paper sample can involve visual, physical, microscopic, & U.V. test. All tests can be made without altering the condition of the document.

Physical examination: The questioned and standard paper should thoroughly be examined in the following manner.

(a) *Appearance of paper*:-

(1). Record the presence of printing, writing and other marks such as stains, indentations, pin marks, staple holes or punch holes etc.

(2) Note the colour and dimensions of paper i.e. its length, width and thickness.

(3) Examine the edges of paper with hand magnifier of good quality or under low power microscope to determine whether the edges have been torn or cut by hand or machine.

(4) Note the number, positioning and nature of folds if present.

Examination under light sources:

1. Examination of the grain size or surface texture under oblique light to know the degree of smoothness of the surface.

2. Examination under transmitted light to determine whether the paper has the same degree of transparency over whole surface.

3. Examination of watermarks, laid marks, wire marks if present in the paper.

Examination under U.V.: Substances when exposed in the path of the ultraviolet rays become visible and coloured. The phenomenon is known as „fluorescence‰. A large number of substances are fluorescent and the same can be rapidly tested under the ultra-violet lamp.

The U.V. Lamp is useful in differentiating different kinds of paper. The fluorescence of pure cotton fibre paper is nearly pure white. Linen paper gives distinctly bluish reaction and wood pulp paper gives a dark colour that in some instances is almost black. Where 2 specimens of paper contain a water mark and are white but actually are composed of different materials, or materials in different proportions, these differences may appear very distinctly under the U.V. Test.

When it is suspected that a page in an account book has been substituted, an

examination of this kind is very important and the fluorescence effect of the substituted pages will be different from that of original papers. It is extremely rare to find a paper which has no fluorescence in U.V. light but both the colour and intensity of the fluorescence are variable.

Note:- The exact age of the paper - not possible.

3.7.3 INK

A coloured fluid or viscous marking material used for writing or printing.

Many disputed document questions relating to ink can be answered in a positive manner and illustrated and explained.

Forensic ink analysis has been a part of questioned document examination and the examiner is often required to solve the following questions-

1. Whether all the writings on a document are written with the same ink or whether some of the writings are written with different inks?

2. Whether the alleged alterations, obliterations or cancellations etc. are done with the same ink or with different inks at a later stage?

3. Whether the entries of different dates in an account book or bahi etc. have been made with one pen and ink at the same time an in one sitting?

4. What is the age of ink/writing in question?

Optical examination of inks with the help of hand magnifier or stereomicroscope to determine:

1. The type of inks used – Ball point pen, Fountain pen, fibre tip pen.

2. Colour of inks – Colour of inks

3. Comparison of secondary colour shades – Examination under U.V. rays are used to compare the degree of fluorescence if any and I.R. rays are used to differentiate dyes and pigments and especially ball point pen inks.

Age of inks: The determination of the absolute age of inks is seldom possible. The main reason for this assertion is that the ageing of ink is governed by a number of environmental factors such as aerial oxygen, light, temperature, humidity, and internal factors such as the nature of ink, width of strokes and the nature of paper bearing the ink etc. It is not practically possible to determine the degree of effect of the environmental factors on a given specimen of ink. A document enclosed in a closed polythene envelope and kept in a closed cabinet will age at a much slower rate than if the same document is exposed to light, temperature, air and humidity. The reason is obvious.

A number of methods based on the change of colour of inks, solubility of inks, amount of ferrous in iron gallotannate inks and iron migration etc., have been proposed by a number of workers but till now, no method has been fully successful to determine the absolute age of inks.

3.7.4 TYPEWRITING MATTER/CYCLOSTYLE COPIES/PRINTED MATTER

The clue for the authorship of type written documents is often through the identification of the machine on which the matter has been typed. For nearly as long as there have been typewriters, there has been a need for scientists to examine disputed type written documents.

The various forms of frauds frequently committed are subject of legal controversy. The documents which are questioned in business transactions and in other fields are pronotes, receipts, contracts, claims and wills etc.

The questions regarding these documents are presented in various ways which may be following:

(i) If a particular matter has been typed by the same machine or by some different machine.

(ii) If the date and figures or words and sentences have been altered.

(i) Whether the sheets of the document are typed continuously in one sitting or in different dates.

(ii) Whether any sheet of will, contract or deed was substituted later on.

(iii) If the additions, alterations and interlineations are made at the same time or at different dates.

(iv) Whether the matter was typed by the particular machine, or by the machine of the same date, number and model.

(v) Whether the matter was typed by a particular operator

The basis for the identification of typewriting is the individuality of every typewriter.

As a means of identifying the individual machine upon which a writing was done, or determining the date of a typewritten document, the examination of the typed impressions should be made in five ways:

i) The design, size and proportions of each of the characters.

ii) The relation of each character as printed to adjacent characters or its vertical and horizontal alignment.

iii) The vertical position of the character in relation to the line of writing, that is, its perpendicularity, or slant to the left or right.

iv) The comparative weight of impression of the upper, lower, right or left sides of each character, or as the machine adjusters describes it, how the type stands ,,on its feet‰ or ,,off its feet‰.

v) The condition of the typefaces of all the letters and characters and the presence of defects, bruises, or ,,scars‰ due to wear or accidents.

A number of different kinds of identifying defects are normally encountered in an

identification problem. One group relates to the letters and characters and how they print (Printing defects). A second group pertains to other operations of the machine (machine defects). There are elements of variation in typewriters that can be recognized from their work, and finally there are some transitory defects. Each group will be discussed more in detail, for there are subgroups of elements within each class of defects.

Study of Design and Master pattern of Type Faces:-

1. Lengths of serifs (small bar at the top and bottom of strokes).

2. Length of horizontal lines in „t‰, „f‰ colon curvature at top of letter „f‰ and bottom of

3. Proportion of upper and lower ovals of letter ‰g‰; space between ovals; relative positions; position of joining lines and ending at upper right.

4. ÂmÂ relation of height to width; length of serifs and upper left and lower right.

5. ÂyÂ angle found in centre; relative length of parts, length of serifs curvature.

6. Numerals-

(a) Figure Â2Â- the characteristics shape, the curve at the top, middle and if at bottom. Any terminal upward stroke.

(b) Figure Â3Â- the characteristics shape of the upper and lower curves.

(c) Figure Â4Â- the proportions of component parts.

(d) FigureÂ5Â-The design of this figure and peculiarities regarding the top and bottom strokes should be noted.

(e) Figure Â6Â- the length and the size of the bottom oval

(f) FigureÂ7Â- the position of the top strokes, slant of the downward stroke and its length.

(g) FigureÂ8Å- the relative sizes and the shapes of the two ovals; whether the upper oval is open; if open, the position of the final stroke and the space left between the upper oval and final stroke.

(h) FigureÂ9Â- the size of the upper oval and slant of the lower curve; any peculiarity in the terminal stroke.

7. A typewriter in perfect alignment will show every letter falling in the middle of an imaginary space. All letters and figures occupy the same area. Approximately 90% of the typewriters have pica type in which the space occupied in one each length inch covers ten characters and twelve characters in elite type. The lines in a single space sheet of type writing are spaced six to the inch. That is each character falls in a fix

position in an area of 1/10X1/6‰. With continuous use or maladjustment, the character may acquire a tendency to fall in a different position.

8. Slant: An aberration in the slant of a letter can be judged with the use of test plate. Generally speaking the letter should be perpendicular to the base line. However, even new machines will be defective in regard to the slant of some of the letters. Order machines develop these defects; the type bar becomes twisted so that the character no longer prints perpendicular to the line of writing. The defect is more readily detected in the tall letters, i.e., b,d.f,h,k,l,t and the capitals.

9. Off its feet: In a new machine, the type face should be adjusted to strike with equal pressure over the entire surface. Divergences frequently occur through maladjustment, use or wear. The typeface no longer strikes the roller with equal pressure on all parts and variations in the density of the ink impression will be observed. The variations in the type face are then said to be Âoff the feetÊ the fault is more readily observed in the broader small letters such as „g,m & w‰ and in the capitals.

10. Other defects: A typewriter is made of hundreds of small parts which may become loose, bent or broken. The result in small defects provide combinations of characteristics that definitely identify a machine. Broken typefaces in which a letter prints with a part missing and worn typewriters which cause characters to print with varying density on successive strokes are the most common defects.

11. Age: „Can the age of a typed document be determined?‰ It is possible to set a limit to the maximum age of the typewritten document by determining the model of the typewriter. For example, if the typing was done with a model that was first made in 1937, obviously the document must have been made since that date.

12. Determining the Typist: Sometimes it is possible to specify that the typing work is done by a particular typist. But for determining this, the suspect typist must be asked to type the matter as dictated by another person.

DETECTING THE OPERATOR - The points for consideration in detecting the operator are:

1. Spelling.
2. Punctuation.
3. Use of Capitals.
4. Division of words.
5. Choice of words.
6. Construction of sentences.
7. Observance or non-observance of grammatical rules.
8. Subject-matter in general.

Comparison is made between questioned and standard typewriting/Cyclostyle copies/printed matter of the similarities / dissimilarities with regard to class and individual characteristics to establish the source.

For the comparison purpose, the standards should be obtained as follows:

1. While obtaining standards of typewriting specimens, use paper of about the same size as that of the disputed document.

2. The specimen should be a full word for word copy of the contents of the disputed Document.

3. Obtain at least a partial text of the typed method in question in heavy, medium, and light touch.

4. Obtain carbon copy samples of every character of the key board. This should be done while placing the ribbon in stencil position and allowing the typefaces to strike the carbon paper directly.

5. At the bottom of every typed specimen make a note of the typewriter, including the make and model, the serial number, when last repaired, and the location where the specimens were made.

6. If the questioned/disputed document is several years and samples of comparison which are about of the same age should be obtained, as type writer also change their characteristics with the usage and wear and tear.

Note: Same procedure will be adopted for the printed matter/cyclostyle copies.
Precautions Necessary
1) The ribbon on a suspected typewriter should not be used to take samples, since this would make subsequent reading of the ribbon more difficult.

2) The typewriter should not be tested, cleaned, or repaired.

3) To eliminate the possibility of having blurred specimens by the use of a worn ribbon, the investigator should deactivate the ribbon by putting the typewriter in the stencil position. He should then use a fresh sheet of carbon and type directly through it on to a sheet of paper ,i.e. there should be no sheet of paper on top of the carbon paper.
Note:- Same will be applied to printed/cyclostyle copies.

3.7.5 TORN DOCUMENTS

Sometimes it is necessary to prove whether the pieces under dispute together form a document or not.

Comparison and physical matching is done to establish the source of the torn pieces of the document.

Note: To establish the identity / non-identity of the torn pieces of document by studying under different procedures see PAPER

3.7.6 CHARRED DOCUMENTS

A document that has become blackened and brittle due to burning or exposure to excessive heat.

Accidentally burnt documents or the documents which have been intentionally destroyed are sometimes received in the laboratory for their restoration and decipherment, i.e. to decipher the original writings.

Charred documents can easily disintegrate and are sometimes damage or break up into brittle charred fragments.

Paper which has been subjected to a high temperature – even though the exposure is insufficient to discolour the paper much less char it - loses practically all its strength and readily breaks up when handled. If the heating has gone on until the paper has turned brown or black then it may fall to a powder on the slightest handling.

It is sometimes of the greatest importance to decipher and may be preserve a document in this state, and for this purpose the charred material must be transferred to a laboratory without suffering any further damage or disintegration. The charred documents should be treated very carefully. The fragile and twisted material must be strengthened and made flexible so that it can be handled and flattened.

At present 3% polyvinyl acetate solution in acetone makes an ideal binding agent for laboratory use on charred paper.
The transfer and stabilization of charred paper

Charred paper, and even more so, paper ash, 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. The whole should then be transferred into a box or on to the centre of a large sheet of wrapping paper. Protected in this way, it can be taken by hand either to the laboratory or to a sheltered place for stabilization, after which it may safely be passed through the post for further treatment at a laboratory.

Stabilization: A solution of polyvinyl acetate in acetone is a powerful adhesive, and if used indiscriminately it may be found at a later stage that some of the treated char has become adherent to the support on which it was resting whilst being treated with the binding solution. To eliminate this possibility, the author stabilizes the charred mass with the binding solution while it is resting on a sheet of glass which has previously been treated with a silicone water repellent. Polyvinyl acetate shows little tendency to adhere to any surface which has been treated in this way. The binding solution is applied with a pipette, made by drawing one end of a three inch length of quill tubing into a capillary and fitting a rubber teat on to the other. The pipette is charged with the solution, and the end of the capillary is applied to the top of the charred mass. It will be found that the solution runs very readily from the capillary into the char. The acetone quickly evaporates, leaving a small area impregnated with solid polyvinyl acetate. The capillary is then moved on to an adjoining area, and the process repeated until the whole of the upper sheet has been treated.

The upper sheet may now be removed. It will probably be found that it tends to adhere to the rest of the charred mass at a number of places. No force should be applied to effect a separation, but fresh solution should be applied to each place in turn when there is any adhesion. The fresh solution rapidly dissolves the excess polyvinyl acetate which is responsible for the unwanted adhesion, so that the upper sheet may gradually be detached. The process is repeated until all the sheets have been stabilized and separated. Once the sheets have dried sufficiently to enable them to be handled safely, they can literally be pulled into shape with little risk of their tearing.

The minimum quantity of establishing solution should be used, as a charred sheet enclosed within a thick cloudy layer of polyvinyl acetate is of little use for further testing.

As the last traces of acetone evaporate from the film, the extreme flexibility which distinguished it at the outset is reduced, but even when all the solvent has disappeared the film of absorbed polyvinyl acetate is sufficiently tough to enable the impregnated charred paper to stand normal handling. If the charred sheets are required in the flat state but free of the binder, they should be rested on sheets of glass in a shallow tray. If a slow current of acetone is allowed to flow over them, the sheets will become limp as the

binder softens and finally dissolves in the acetone. The acetone is run off and replaced by fresh solvent to remove the last traces of binder. When the acetone has evaporated, the sheets of charred paper will be found to be firmly adherent to the glass, probably due to traces of binder absorbed on the glass surface. If the charred sheets are desired free of the glass support, the glass should be treated with a silicone water repellent solution before use.

Charred documents may be preserved in a number of ways. The most satisfactory is to bind them between sheets of glass. Because of the fragility of glass, sheets of transparent plastic, such as Perspex, would be more suitable but very much more expensive.

Deciphering Charred Documents

It is sometimes greatest importance to decipher a charred document and this may help to preserve a document in this state. The most satisfactory method of deciphering a charred document is to flatten it and then to adjust the lighting so that the residue of any writing or printing thereon is rendered visible because the reflecting power of the surface is modified.

Examination or photography under infrared radiation can, however, be helpful and is non-destructive. This may appear surprising because carbons absorb infrared as well as all other wavelengths, and the black fragments seem to contain much carbon. In practice, however, the contrast if often improved, presumably because the inks absorb infrared radiation while the charred paper is black because of partly converted resinous material rather than because it has degraded to elemental carbon.

3.7.7 PHOTOSTAT/CARBON/FAX COPY DOCUMENTS

Greater access to photocopying facilities has been a consequence of advances in reprographic technology and the falling costs of producing copies. Many modern offices now have photocopiers and in many areas shops also offer photocopying services. This wide spread availability of photocopiers has lead to forensic document examiners encountering many photo copies documents in their case work. As well as the fax machine has now become an essential machine in many modern offices. Printers, faxes

and photocopiers which were once only in the hands of specialist users are now common place items in every day life, all producing documents which could be subject to forensic examination.

Photostat: Reproduction of original copy is made by projecting the image of the document on to sensitive paper inside a large camera specially designed for the purpose.

Carbon: Copy of original made by using carbon paper.

Fax: Facsimile transmission of images usually of a document consisting of typed/printed/hand written text or drawing. The transmission of text or data is achieved through the telecommunication link, usually the telephone net work.

The examination required is:

Whether a given questioned/disputed/suspected writings or signature in the Photostat or carbon copies is written by the suspected or not.

For the authorship or to eliminate the writer or at times to detect the forgery, it is similar as that of writings / signatures already discussed.
To decipher the original writings from the faded fax.

By using different light sources U.V., IR etc. the original text or data from the faded Fax messages can be deciphered.

LIMITATIONS

A. : Photostat

(i) The writings/signatures/initials, matter available on the Photostat copies do not exhibit the core handwriting parameters such as line quality, speed rhythm, movement etc. and the minute details like design of the letters, type face defects, machine defects etc. in case of type writing and printed matter.

(ii) Photostat copies are susceptible for manipulation such as lifting, tracing, interpolations, additions, insertions etc., in the process of photocopying.

(iii) Even the erasures can also be not detected.

(iv) Faint copies are not suitable.

B. : Carbon copies: Faint carbon copies

C: Fax: Depends upon the time, nature of exposure the fading process varies.

3.8 INSTRUMENTS

Some of the instruments that can be used in the analysis of questioned documents are:
Stereomicroscope
Video Spectral Comparator: It is produced by Foster and Freeman Limited, U.K has been designed especially for document examination and contain in one unit all the apparatus required to detect the differences in inks on documents and paper. The apparatus incorporates a CCD camera (Which is very sensitive in the infrared region) a video monitor, light sources and filters for both the exciting radiation and the reflected or fluorescent light. This instrument is based on the principle of absorption theory. At

different wavelengths, depending upon the ingredients and composition of the inks/ paper they can be differentiated. The VSC is capable of exploiting infrared absorption, infrared luminescence, U.V fluorescence and transmitted light to determine differences in inks on documents, texture of paper and examine alteration and obliteration ,chemical and mechanical erasures ,indentations and to decipher the original writings and also to super impose the traced forgeries.

Electrostatic Detection Apparatus (ESDA): An entirely different technique, which does not rely on a visual examination and does not damage the document, is the electrostatic method of detection. Impressions made on paper affect its dielectric properties, so an electric charge applied to the surface produces a potential different where impressions are present from that of the surrounding area. The effect is of considerable value to the

document examiner and is exploited by using a piece of apparatus i.e. ESDA designed especially for the purpose.

The Electrostatic Detection Apparatus (ESDA) made by Foster and Freeman Ltd (25 Swan Lane, Eveshma, Worcs., WR11 4PE), comprises a flat bed of sintered bronze, a porous metal, from below which the air is evacuated by a vacuum pump, a holder or a reel of thin Mylar^{TM} film (a transparent plastic) and a thin wire in a suitable holder which can be charged to about 8 kilovolts . To use the apparatus the document is placed on the bed of sintered bronze, which is electrically earthed, covered with Mylar film, and the vacuum is applied. This causes the Mylar and the document under it to be sucked tightly down on the metal bed. A charge is then applied by passing the highly charged wire, called a corona discharge unit, several times just above the surface of the Mylar. This produces on the Mylar film an electrostatic charge the potential of which is dependent on the dielectric properties of the paper immediately below it. Because these are different where there are indented impressions, there is a difference of potential on the Mylar film corresponding to the position of the impressions.

The difference in potential between the sites of the impressions is then detected by applying photocopy toner powder to the Mylar surface in one of two ways, or by a combination of both. Included in the apparatus is a pump which forces a cloud of toner powder from a reservoir through a nozzle, charged at the polarity opposite to that of Mylar surface, which is fixed into a plastic hood. The hood is placed on the flat metal bed so that it covers the document and Mylar film. When the pump is switched on the toner powder cloud is mainly attracted to the impressions as these are the areas of greatest opposite charge The second way of applying the toner is to pour a developer consisting of toner and glass beads over the surface. The bed is hinged so that it can be tilted, allowing the developer mixture to cascade across the whole area of the Mylar covered document. The greater potential at the site of the impressions attracts the toner away from the glass beads.

Both methods of detection of the differences of potential leave black toner adhering to the surface of the Mylar exactly on the site of the impressions. Most impressions will appear as a black or gray image contrasting with the general light gray colour of the rest of the Mylar surface where some toner has been evenly deposited. This enables many of the impressions to be clearly identified and others to be read with a varying degree of difficulty depending on the contrast between the image and the background. Generally, the deeper the indentations are, the blacker will be the image, but very deep impressions will often be seen in reverse, appearing white against the gray background.

The image produced on the Mylar film can be preserved by covering the surface with a sheet of adhesive transparent plastic of the type used as a protective cover for books and other documents. The Mylar film, together with the image on it, is lifted by the adhesive sheet and forms a transparency which can be trimmed to make a document on which the indented impressions are permanently recorded. Although much can be read while the image is still on the apparatus, more can often be seen on the resultant combination of image, Mylar and Plastic sheet. The transparency or 'lift', which has something of the appearance of a photographic negative, although there is no connection between the two, can be used as an exhibit in later litigation.

The transparency can also be used to overlay writing which is suspected of having caused the impressions; if the writing is indeed the source there will be a perfect fit. The relative alignment of the impressions can also be similarly tested against that of the writing.

The electrostatic method is very sensitive, detecting impressions too faint to be seen, but is not successful in certain situations. A line of writing, although clearly indented into the paper, will not react in the same way as other indentations, but will usually appear in reverse, as a white line on the gray background. This is an advantage, because writing on the paper on which impressions are found could otherwise be confusing and make the impressions largely indecipherable. As it is, there is sometimes a problem when two or more pages of impressions are found on a page and their superimposition causes difficulties in interpretation.

Electro statically produced images can be obtained from both sides of a piece of paper, indicating that it is not only the depressions which are detected; it is sometimes found

that the back of a page will provide a better result than the front. It appears that dryness of the ambient conditions and in the document are not conducive to good performance, and improvements in weak images can be made if the paper, the toner beads or the room are humidified.

With the help of this instrument, in the same process, the secret writings produced by any invisible inks like body fluids, vegetable juices and chemicals etc. can also be developed.

3.9 PHOTOGRAPHY

In all cases the photography of both Questioned & Standards of all encircled portions is carried out which include photography under UV, IR, Microscope and other special effects of photography. If the photographs are required for critical studies, copies are obtained. Otherwise, negatives are preserved for printing as and when the case comes for trial/evidence.

Photography for enlargements, special effects and reference: There are three main functions of photography in document examination.

(i) To make a permanent record of the document.

(ii) To detect certain features which are not visible and for which other methods are unavailable or less convenient, and

(iii) To prepare material from which demonstration charts for use in courts are prepared.

Role of Photography in Expert examination and testimony

Expert testimony is of course, more effective if submitted with suitable photographic enlargements. The forensic document examiner is no longer confined to the comparison

of signatures or writings, rather he has to furnish opinion on examination of paper, inks, writing instruments, erasures, alterations, charred documents, typewriting, sequence of strokes, writing over folds and old faded writings etc. Such examinations require normal as well as specialized photography with filters, ultraviolet rays, Infrared rays, compound microscope, oblique light, transmitted light and X-rays etc.

With the advent of modern sophisticated electronic cameras we claim that anything that can be seen can be photographed and such claim is probably right.

Photography plays a significant role in almost every phase of document examination. Some of its important uses are briefly described below:-

1. If the original document is frequently handled and examined by the Courts, Lawyers, or witness, it is likely to be soiled, defaced or even torn and ultimately it may be difficult to ascertain whether the document itself is genuine or not. In order to keep a permanent record of questioned document or any other important document, it can be photographed. Such photographs may also be of great importance in case of subsequent mutilation or fraudulent tampering with its contents.

2. The writings, signatures or parts thereof can be accurately enlarged with the help of photography for the detailed study of writing characteristics and for finding out and demonstrating minute defects of forgery. In some cases, the writings are too small for proper examination and their photographic enlargements are the only way to demonstrate the observations.

3. A number of copies/enlargements of signatures or writings can be made, which can be examined individually by different lawyers, experts or judges. Such enlargements also help in a great way to compare signatures or writings by placing them side by side. In some cases, the signatures are present on different pages/leaves of an account book or register etc. as such it may be very difficult to compare them without placing them side by side with the help of photography.

4. The important parts of signatures or writings can be cut apart from their enlarged photographs and assembled to prepare convincing demonstrative charts. (Juxta posed writings) Fig. 16.

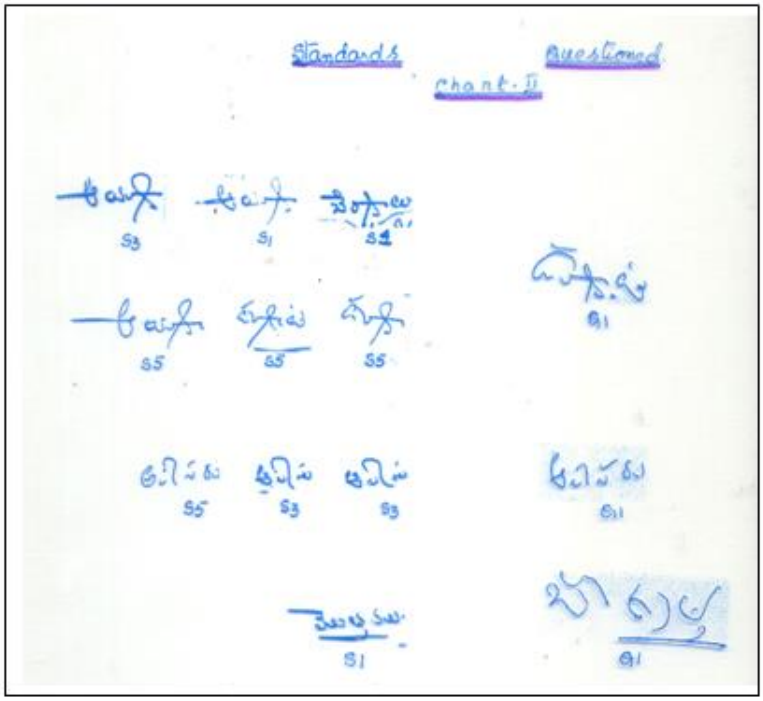


Fig. 16: Juxta-posed writings

5. Sometimes, the signatures are present on such type of papers whose background design causes hindrance in the process of comparison (such as signatures or thumb impressions on revenue stamps). To surmount this difficulty, the background may be eliminated in photographs by using filters of appropriate colours over the camera lens.

6. Photographs taken with transmitted light (light passing through the paper) are useful for examination and recording of watermarks, laid marks or other marks, and any thinning effect in the paper caused by erasure to remove some writings. Oblique light photographs of indented writings/impressions and disturbance in the surface fibers due to the application of physical erasure or any other reason may clearly reveal the true picture and help a lot to record indented writings/impressions.

7. Photographs through microscope (Photomicrographs) prove indispensable in illustrating minute details such as sequence of intersecting lines, writing across paper folds, nature of fibers of paper, nature and width of ink lines, alterations, erasures, over writings and signs of tracing etc., which may not be visible or appreciable otherwise.

8. In case of traced forgeries, photographs, superimposed photographs and transparencies of forged signatures and the model signature may render a great assistance to show their coinciding strokes.

9. Sometimes the alterations, additions, erasures may only be decipherable under ultraviolet rays. The only way to preserve and demonstrate those observations is to photograph them by using suitable filters. The faded writings, sometimes, may also be rendered visible by ultraviolet rays and they can be recorded by photography.

10. Photography may also prove useful in differentiating inks appearing similar to the naked eye but having different tints. With the help of colour filters of different shades, it may be possible to distinguish and record delicate difference in the tints.

11. The obliterated writings and writings of charred and old documents may sometimes also be deciphered by infrared rays and recorded, and made visible photographically.

Many other situations may arise in which photography may become not only useful but also necessary. The role of forensic document examiner is two folds. He should not only be able to find out the truth, but he should also be able to properly demonstrate his observations and findings and convince the persons concerned.

3.10 HANDLING AND PRESERVATION OF DOCUMENTS

Proper handling and preservation of documents is also very important.

The following are some of the Do's and Don'ts in this regard.

Documents should not be handled carelessly.

1. Documents should be Xeroxed and utilized by Investigating Officers.
2. Originals must be sent for Expert Examination.
3. Documents should not be cut, torn or trimmed. Documents should not be folded or unfolded.
4. Partially torn documents should be joined properly with adhesive tape to prevent further deterioration.
5. Documents should not be exposed to moisture, sun-light etc.
6. While sending documents they should be preserved in cellophane envelopes separately.
7. Documents should not be touched with erasure of any kind nor should any labels be stuck with gum.
8. Care should be taken that no oil stains or food particles fall on the documents.
9. Documents should not be punched, pinned or stapled. Only paper clips should be used.
10. The Investigating Officer / Forwarding Authority should not make any additions or underlings on the portions containing the disputed and standard writings and signatures.
11. The disputed portions should be encircled properly with a pencil without disturbing the disputed portions. The same thing can be followed in case of admitted standards.
12. Initial, date and numbering etc., should be put outside the encircled portion.

3.11 GLOSSARY

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

Natural Variations: Normal or usual deviations in the formation of letters found between repeated specimens.

Class characteristic: Not all characteristics encountered in document examination are peculiar to a single a person or thing and one that is common to a group may described

as a class characteristics.

Individual Characteristic: A characteristic that is highly personal or peculiar and is unlikely to occur in other instances.

Microscopic Examination: Any study or examination made with microscope in order to discover minute physical details.

Disguised writing: A writer may deliberately try to alter his usual writing habits in hopes of hiding his identity. The results, regardless of their effectiveness, are termed disguised writing.

Questioned / Disputed Document: All documents are not disputed documents. When the genuineness of the document, or, the contents or facts related to its production arouses suspicion, such document will termed as „Questioned / Disputed Document‰.

Writings: Visual expressions in the form of signs or marks made by a person by coordinated effort of brain, nerves and muscles, useful as a means of communication.

Signature: Signature is an expression in the form of writing but with limited number of characters - highly individualized due to regular practice and use and represents an individual.

Initial: Short form of signature

Fraudulent signature: A forged signature. It involves the writing of a name as a signature by someone other than the person himself, without his permission, often with some degree of imitation.

Patching: Retouching or going back over a defective portion of a writing stroke. Careful patching is a common defect in forgeries.

Pen lift: An interruption in a stroke caused by removing the writing instrument (Pen) from the paper.

Rhythm: That element of the writing movement marked by regular or periodic recurrences. It may be classed as smooth, intermittent or jerk in its quality.

Tremor: A writing weakness portrayed by irregular, shaky strokes.

Alterations: Any change which gives the document a different meaning from that which originally possessed.

Additions: Additions are sometime made to change the original value or meaning of the documents.

Insertions: Insertions are writings added in between the words, lines, paragraphs

Altered document: A document that contains some change, either as an addition or a deletion.
Inter-lineation: The act of inserting writing or typewriting between two lines of writing.
Insertion: The addition of writing and other material within a document such as between lines or paragraphs, or the addition of whole pages to a document.

Obliteration: The blotting out or smearing over of writing to make the original invisible or undecipherable.
Invisible inks: Inks which visible after some treatment are known as invisible inks.
Secret writings: Writings which are not visible to the naked eye.
Watermark: A translucent design impressed on certain papers during their course of manufacturing.

Surface Texture: The surface of any sheet of any sheet of paper when viewed under magnification is not absolutely smooth and flat but irregular and rough.

Ball point pen: A writing instrument having as its marking tip a small, freely rotating ball bearing that rolls the ink on to the paper. Many of these pens use a highly viscous, non-aqueous ink, but in recent years construction of some pens has been adapted to use water based inks.

Fountain pen: A modern nib pen containing a reservoir of ink in a specially designed chamber of cartridge. After complete filling, the pen may be used to write a number of pages without refilling.
Fiber tip / porous tip pen: A modern writing instrument in which the marking element point consists of a porous material through which the ink can flow. These pens are commonly known as fiber tip or felt tip pens or may be referred to as soft tip pens.

Rebound: A character prints a double impression, with the lighter one slightly off set to the right or left.

Off its feet: Condition of a type face printing heavier on one side or corner than the reminder of its out line

Pica: 10 Characters per inch
Elite: 12 Characters per inch
Alignment defect: Characters that right in properly in the following respects: A twisted letter, horizontal mal-alignment or vertical mal-alignment, or a character off its feet.

Transitory defects: An identifying type writer characteristic that can be eliminated by cleaning the machine or replacing the ribbon.

Twisted letter: Each character is designed to print at a certain fixed angle to the base line. Wear and damage to the type bars and type block may cause some letters to become twisted so that they lean to the right or left of their correct slant.

GLOSSARY

1. Charred document

2. Erasure

3. Exemplar

4. Indented writings

5. Infrared luminescence

6. Natural variations

7. Obliteration

8. Questioned document.

LEARNING OUTCOME

After studying this unit you should be able to:

1. Define the term ‘Questioned Document’.

2. Know what the common individual characteristics are associated with handwriting.

3. List some important guidelines for the collection of known writings for comparison to a questioned document.

4. List some of the techniques document examiners use to uncover alterations, erasures, obliterations, and variations in pen inks.

SUGGESTED READINGS

6. Questioned Documents - Albert S. Osborn

7. Suspect Documents - Wilson R. Harrison

8. Scientific Examination of Questioned Documents. - Ordway Hilton

9. The Scientific Examination of Documents Methods and Techniques - David Ellen.

10. Identification of Handwritings, Fingerprints, Footprints, and Detection of Forgery. - B.L.Saxena

11. Disputed Documents, Handwriting and Thumbprint Identification - Hardless – Revised by T.J. Gajiar

UNIT IV

LEARNING OBJECTIVES:

In this unit you will be introduced to:

1. The techniques for rifling a barrel.
2. The class and individual characteristics of bullets and cartridge cases.
3. Use of the comparison microscope to compare bullets and cartridge cases.
4. The procedure for determining how far a weapon was fired from a target.
5. The laboratory tests for determining whether an individual has fired a weapon.
6. The aspects to differentiate between an entrance and exit wound.
7. The collection and preservation of evidence.
8. The precautions and guidelines for the collection of physical evidence.

UNIT IV- BALLISTICS

4.0 INTRODUCTION

Ballistics is the study of projectiles in motion. The term ballistics is derived from the Latin word 'ballista' which refers to a crossbow like device for throwing stones by means of twisted ropes. Forensic Ballistics is the examination and identification of firearm, cartridges, fired cartridges, fired cartridge cases, bullets, gun powder, wads, pellets, etc. Further ballistics section links the firearm with fired cartridge cases and bullets, determine the range of fire & angle of firing etc.

Physical evidence pertaining to Ballistics may be available in *Murder, assault, suicide, attempt to murder, dacoity* and in many other cases.

4.1 CLASSIFICATION OF BALLISTICS

Ballistics can be broadly divided into three parts:

1. Internal Ballistics
2. External Ballistics and
3. Terminal Ballistics

1. **Internal Ballistics:** Internal Ballistics deals with the motion of projectiles from the time the trigger mechanism is activated till it leaves the muzzle end of the barrel. The rate and manner of burning of the propellant, the nature of development of gas pressure on the gun, barrel and breech, etc., are studied under this read.

As soon as the primer ignites the propellant, gas is generated which rapidly builds up a considerable pressure. This pushes the projectile out of the case and up the barrel. As the projectile accelerates up the barrel, it makes space for the gas to expand so gas pressure declines. It is still significant when the projectile leaves the muzzle, resulting in a rapid expansion into the open air causing the characteristic sound of a gun firing. This final expansion, coupled with the end of the friction between the projectile and the barrel, results in a final boost to the projectile so its maximum velocity is attained just beyond the muzzle. It is difficult in practice to measure the forces within a gun barrel, but the one easily measured parameter is the velocity with which the bullet exits the barrel 'muzzle velocity'.

Different weapons operate at different gas pressures; pistols and shotguns generally work at much lower pressures than rifles and automatic cannon. Higher pressures require a bigger gun.

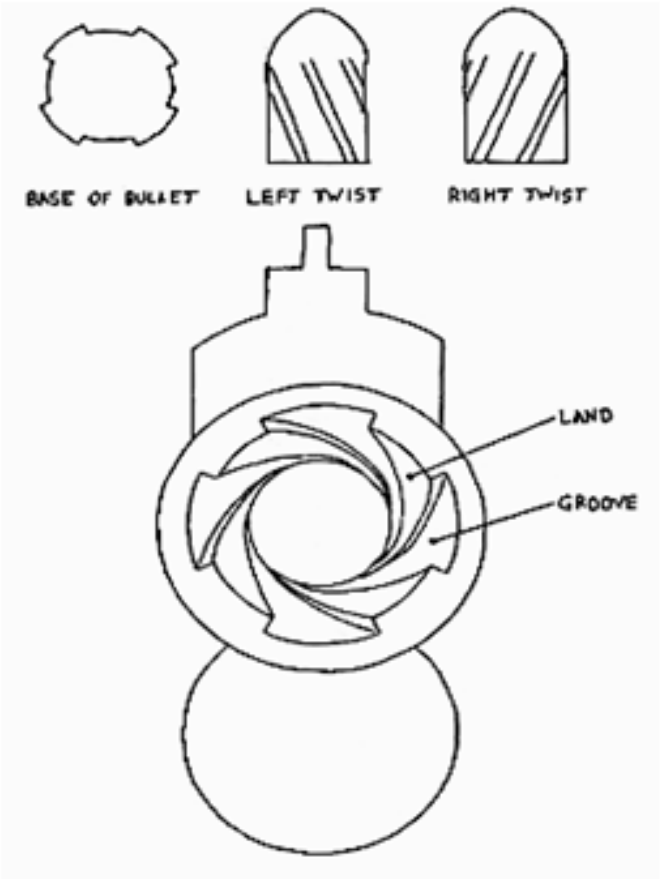
Silenced (or, more accurately, suppressed) weapons are fitted with a suppressor; a container attached to the muzzle (or, in specially-designed weapons, integrated with the barrel). This allows the gas to expand within it in a controlled way, during which time it is cooled down and drops in pressure, to be released slowly afterwards instead of bursting violently out of the muzzle

2. **External Ballistics:** External Ballistics deals with the motion of projectiles during the rest of its trajectory through the air. The stability of the projectile during the flight, wind deflection, gravitational pull, etc., can be studied under this branch.

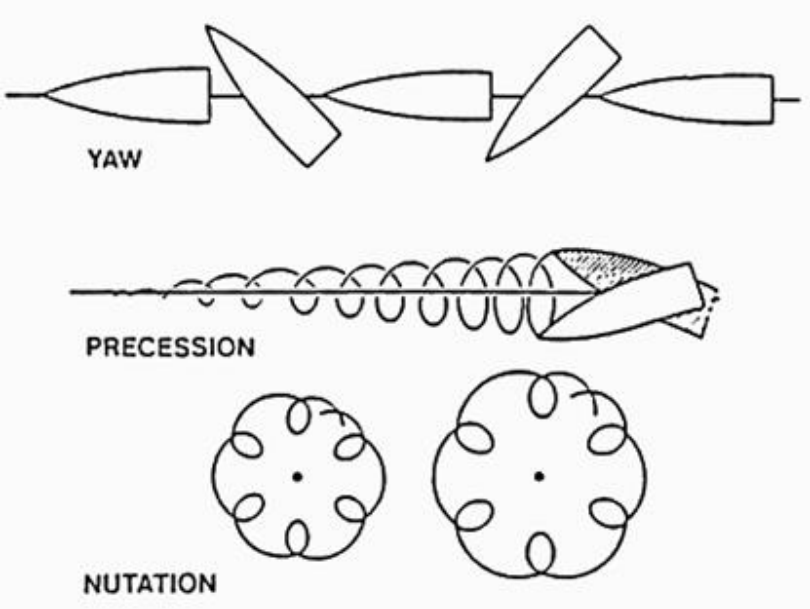
The two key factors which determine the external ballistics of a projectile are the muzzle velocity and the ballistic coefficient. Ballistic coefficient is calculated by dividing the sectional density by the form factor. The ballistic coefficient is significant because it determines the rate at which the projectile slows down, and in conjunction with the muzzle velocity this decides the maximum range (at any given elevation) and the time of flight to any particular distance. The time of flight in turn decides the amount by which the projectile drops downwards as this happens at a constant rate due to gravity. The curved path of the projectile which results from the muzzle velocity, the ballistic coefficient and gravity drop is called the trajectory.

There are two elements which decide the ballistic coefficient (BC); the sectional density (SD) and the form factor (FF). The SD is a simple calculation as it is the ratio between calibre and projectile weight. The higher the SD figure, the better the velocity retention. The FF measures the aerodynamic efficiency of the projectile's shape, it is difficult to calculate and only an approximate value can be taken. A projectile with a pointed nose will have much less air resistance than a simple cylinder, and it will therefore have a better FF.

An important aspect of external ballistics is the stability of the projectile. If an ordinary bullet or cannon shell were fired from a smooth bored gun, it would probably start to tumble, ruining its aerodynamics and accuracy. The answer was found to be to cause the bullet to spin rapidly by cutting spiral grooves into the barrel, called rifling. *Rifling consists of grooves cut or formed in a spiral nature, lengthwise down the barrel of a firearm*. In firearm examiner lingo we refer to the rifling as *lands* & *grooves*. The lands are the raised areas between two grooves. The rifling pattern in the barrel that fired a particular bullet can be determined by counting the number of groove or land impressions around the circumference of the bullet. Then, by holding the nose of the bullet pointing away from you, the direction the impressions run away from you (either to your left or right) determines the direction of twist.



Rotational forces are in effect that keep the bullet off a straight axis of flight. These rotational effects are diagrammed below:



Yaw refers to the rotation of the nose of the bullet away from the line of flight. Precession refers to rotation of the bullet around the center of mass. Nutation refers to small circular movement at the bullet tip. Yaw and precession decrease as the distance of the bullet from the barrel increases.

3. **Terminal Ballistics:** Terminal Ballistics deals with the impact of projectiles upon the target. It includes the study of wound ballistics.

There are two different aspects to this; the effect of projectile strike against soft targets (animals or people) and the effect against armour. The subject of the penetration of armour is highly technical and complex. Furthermore, different types and qualities of armour used to test projectiles against make comparisons difficult.

A rifle bullet will be destabilized when hitting a soft target and will tumble. This is because its shape means that the centre of gravity of the bullet is towards the rear so it naturally prefers to fly base-first. Spinning the bullet by means of the rifling keeps the bullet flying point-first through the air, but flesh is about 400 times denser than air so spinning is no longer enough; the bullet destabilizes and turns over to travel base-first, a process known as tumbling. Thereby it inflicts a far more serious wound than if it carried on traveling straight through the body.

Incidentally, bullets designed for penetrating heavy game animals like elephant – which need to penetrate very deeply in a straight line and must therefore not yaw or tumble – have long, parallel sides and blunt round noses, just like early military rifle bullets. Despite yaw, an intact bullet that comes to rest in tissue generally has its long axis aligned along the path of the bullet track, though its final position may be either nose forward or base forward.

Not all bullets tumble at the same rate. Other things being equal, small bullets will tumble more quickly than large ones, but the design of the bullet is also important; some visually identical bullets will tumble at different speeds, generally depending on the internal construction.

If a bullet has a relatively weak jacket, the stresses of tumbling may cause it to break apart while it is travelling sideways through flesh – a process known as fragmentation – which further increases the wounding effect.

Bullets produce tissue damage in three ways:

1. **Laceration and crushing** – Tissue damage through laceration and crushing occurs along the path or "track" through the body that a projectile, or its fragments, may produce.
2. **Cavitation** – A "permanent" cavity is caused by the path (track) of the bullet itself with crushing of tissue, whereas a "temporary" cavity is formed by radial stretching around the bullet track from continued acceleration of the medium (air or tissue) in the wake of the bullet, causing the wound cavity to be stretched outward. For projectiles traveling at low velocity the permanent and temporary cavities are nearly the same, but at high velocity and with bullet yaw the temporary cavity becomes larger.
3. **Shock waves** – Shock waves compress the medium and travel ahead of the bullet, as well as to the sides, but these waves last only a few microseconds and do not cause profound destruction at low velocity. At high velocity, generated shock waves can reach up to 200 atmospheres of pressure.

Wounding is an extremely complex situation with variables of bullet size, velocity, shape, spin, distance from muzzle to target, and nature of tissue. These factors are interrelated, and the wounding potential may be difficult to predict even under controlled test conditions. In an actual forensic case, few of the variables may be known, and it is up to the medical examiner to determine what can be known from examination of the evidence.

4.2 FIREARM

A firearm is a device which can set off projectiles to a considerable distance with high velocity. The force to propel these projectiles comes from the propellant. When the propellant burns it builds up gaseous pressure which propels the projectiles out of the barrel of the weapon. A firearm is so called because a flame is generated, and it is this flame which is responsible for propelling the projectiles.

Classifications of Firearms

The modern firearms are classified on the basis of several characteristics.

- *Handling Characteristics* – Handguns, shoulder arms.
- *Bore Characteristics* – Smooth bore and rifled bore firearms.
- *Loading Characteristics* – Muzzle loading, breech loading, or magazine loading firearms.
- *Action Characteristics* – Lever-action, bolt-action, self-loaders, automatics.
- *Firing Characteristics* – Single shot, repeaters.
- *Use* – Sporting firearms, service firearms.

Bore

Bore is the term associated with smooth bore fire arms. It is a number indicating the size of the internal diameter of the barrel, and represents the number of spherical balls of pure lead each exactly fitting the inside of the bore which together make up a pound. For example, the internal diameter of a 12 bore shotgun is equal to the diameter of a spherical ball of pure 1/12 pound of lead. The internal diameter of the 12 bore gun barrel is 0.729 inches.

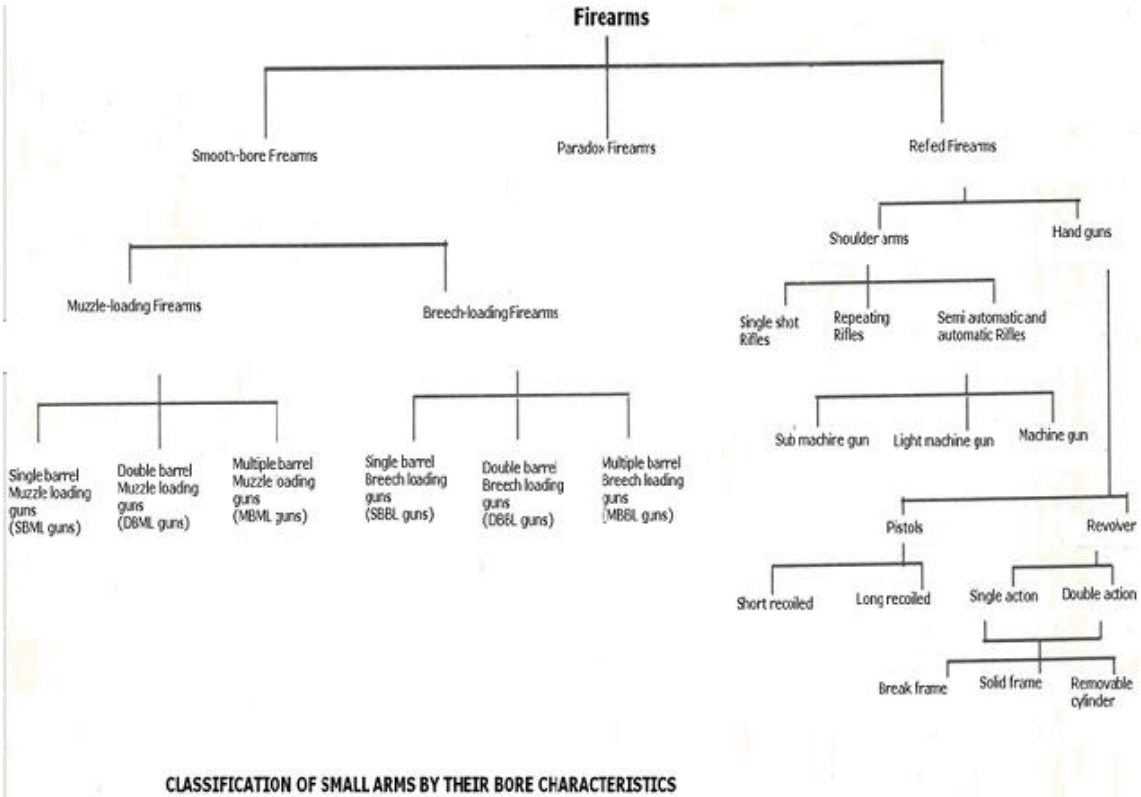
Shotgun

Shotgun is an important firearm, which falls in the category of shoulder arms. All shotguns are smooth bore firearms, that is, the cross section of the barrel at any point makes a perfect circle. They are known as shot guns because they fire a single ball, slug or a charge consisting of a considerable number of lead pellets (shots). A shotgun may be single or double barrelled. The barrels may be joined side by side or they may be one over the other. The double- barrelled guns are either ‘hammer’ or ‘hammerless’ types, the latter being the more modern type. In hammer guns the hammers are cocked with the hand. In hammerless the hammer action is enclosed in the body of the gun and the hammers get cocked automatically when the breech is opened and closed.

The shotguns barrels have varied bore diameters and are designated by a number and gauge or bore. Thus, in a 12-bore shotgun, the internal diameter of the barrel is equal to the diameter of a spherical lead ball made of pure lead and twelve such lead balls, which correspond to the diameter of the barrel together, weigh a pound. *A 12 bore shot gun will have 0.729 inches bore diameter.* There are 10 gauge, 16 gauge, 20 gauge, and 28 gauge shot guns. Only exception is that when the diameter of a smooth bore barrel is less than 0.5 of an inch i.e., smaller than 32 gauge, the bore is designated in decimals of an inch e.g., 0.410 inch musket.

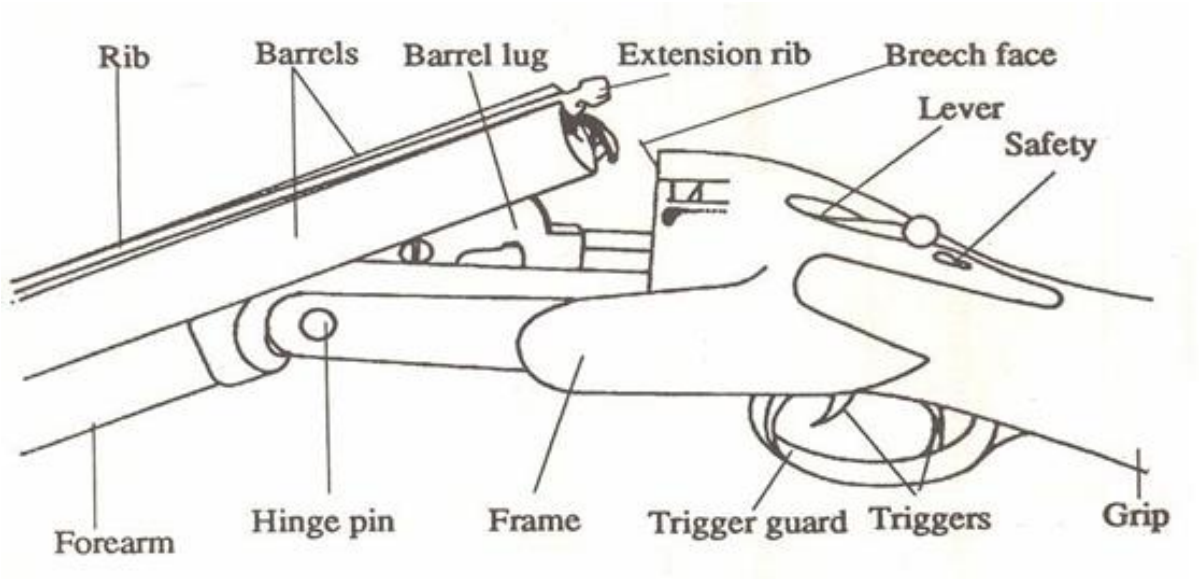
Shotgun barrels are often narrowed down to reduce the diameter of the barrel near the muzzle, to control the dispersal of the shot charge and thus increase the effective range. This constriction is known as *choke* and varies from 1 to 0.25 mm. The two ends of the barrel of a shotgun are called the breech and the muzzle end. Breech end is also known as chamber end. The breech end of the barrel has a special cavity to house a cartridge. The chamber end carries extraction and ejection mechanisms. When the cartridge is loaded from the breech end it is known as breech loading firearm. All modern firearms, whether rifled or smooth bore are breech-loading weapons.

Shotguns of muzzle loading type are also known. In this the cartridge components are loose and inserted from the muzzle end. A percussion cap, placed on the nipple, when struck by the external hammer sets the projectiles in motion in case of muzzle loaders.



CLASSIFICATION OF SMALL ARMS BY THEIR BORE CHARACTERISTICS

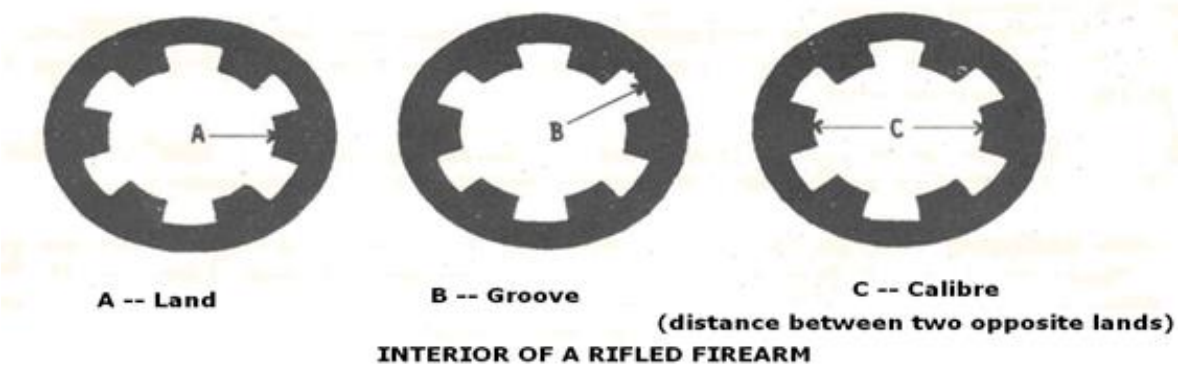
S.B.M.L., D.B.M.L., S.B.B.L., D.B.B.L., are examples of shotguns.



SCHEMATIC DIAGRAM OF DOUBLE BREECH LOADING GUN

Rifles

All rifled arms fire a single bullet. They have a much longer barrel and can fire high-powered ammunition. Rifles are characterized by their calibres. The calibre is the actual measure of the bore diameter of the barrel between two opposite lands. The calibre is measured in decimals of an inch e.g., 0.303‰, 0.22‰, 0.38‰ etc., or in millimetres, e.g., 7.65 mm, 9 mm etc.



INTERIOR OF A RIFLED FIREARM

The rifled barrels are grooved. The grooves are cut in the form of spirals from inside the bore. The raised parts between these are known as lands. The number of grooves in a rifle varies. The width of the grooves in the barrel is cut in various ways. The spiral groove is obtained by gradually and uniformly turning the cutter, while cutting the groove. This turning is called the *twist* and the angle of the turning is called the *pitch.* The rifling in the barrel gives gyratory motion (spinning) to the projectile, which continues even in flight. The gyratory motion maintains the bullet in stable nose-on flight, which reduces the air resistance and enhances the degree of accuracy.

Rifles are of different actions. Most common are bolt action and semi-automatic action. In bolt action loading and unloading operations are carried out through a bolt with a knob. The firing pin assembly remains inside the bolt. The bolt head is fitted with an extractor, 0.303, 0.22 are examples of rifles.

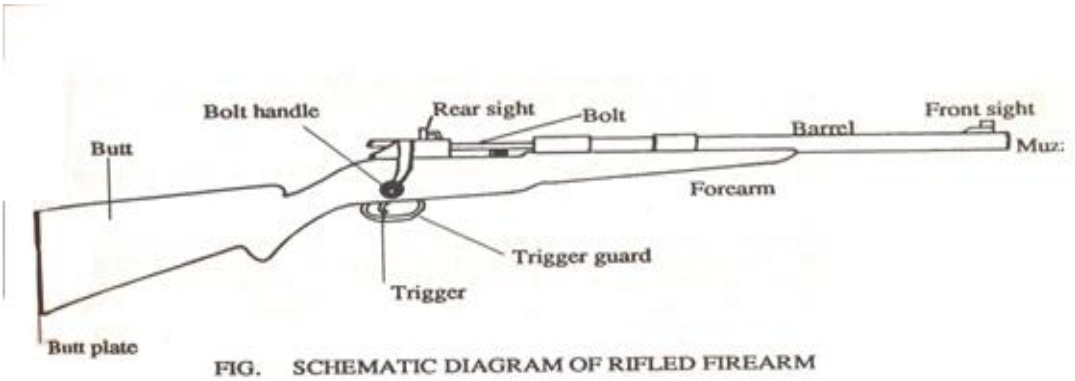


FIG. SCHEMATIC DIAGRAM OF RIFLED FIREARM

Hand guns

These firearms have short barrels and grips. These can be operated with one hand.

a) *Pistols:* These are hand arms having short barrels which are usually not more than 10 inches long. Pistols have a magazine, which is enclosed in its grip and it can be held and fired with one hand. Pistols are normally semi-automatic or self-loader type, in which by the pull of trigger a cartridge is fired. Its effective range is 100 yards and muzzle velocity is 1200 ft/sec. E.g., 9 mm, 7.65 mm pistols.

FIG. THE PARTS OF A PISTOL

b) *Revolvers:* The revolver has a revolving cylinder arranged behind the breech end of the barrel, which can accommodate 4 to 7 cartridges. The size of the revolvers also vary e.g., 0.32‰, 0.38‰, 0.45‰. For every trigger operation, the mechanism rotates the cylinder in such a way that the next chamber becomes aligned with the barrel of the revolver. The barrel length is about 7 inches and effective range is about 100 yards. In the single-action revolver, the hammer must be cocked by hand after each shot and the weapon is then fired in the usual way by pressing the trigger. In the double action type of revolver, the hammer can be cocked by hand, but it can also be cocked and fired by a prolonged pull of the trigger.

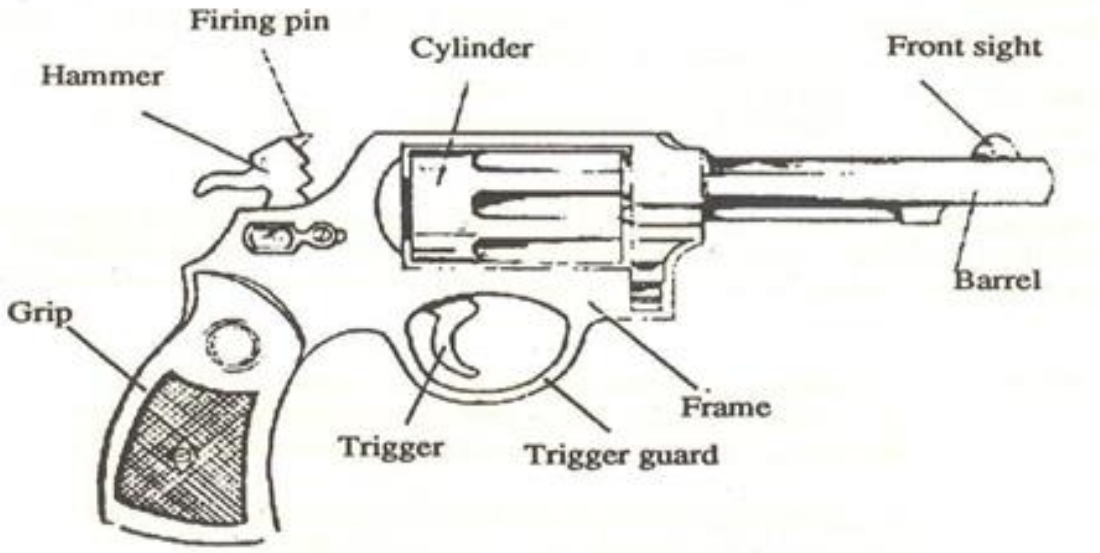


FIG. THE PARTS OF A REVOLVER

The differences between pistols and revolvers can be summarized as follows

Pistols *Revolvers*

1. Magazine is arranged in the grip.
2. The magazine accommodates more than eight cartridges.
3. The trigger pull is less.
4. The weapon is light in weight.
5. A misfired cartridge cannot be easily remove

1. A cylindrical magazine is arranged behind the breech end of the barrel.
2. Normally the cylinder accommodates less than eight cartridges.
3. The trigger pull is more.
4. It is somewhat heavy (due to its cylinder)
5. A misfired cartridge can easilybe removed.

Miscellaneous firearms

There are other types of firearms which do not fall into the above classification pattern but which police officers frequently come across. Country-made firearms or improvised firearms fall into this category. Other types are toy firearms, freak firearms, etc.

Improvised firearm or country made firearms: These are homemade firearms usually manufactured by blacksmiths using water pipes and standard ammunition is used. Each of these firearms is unique in its mechanism and mostly smooth barreled.

4.3 AMMUNITION

The standard ammunition is made of the following basic components:

- Cartridge case
- Primer and primer cap
- Powder or propellant
- Wads
- Projectile

Cartridge Case

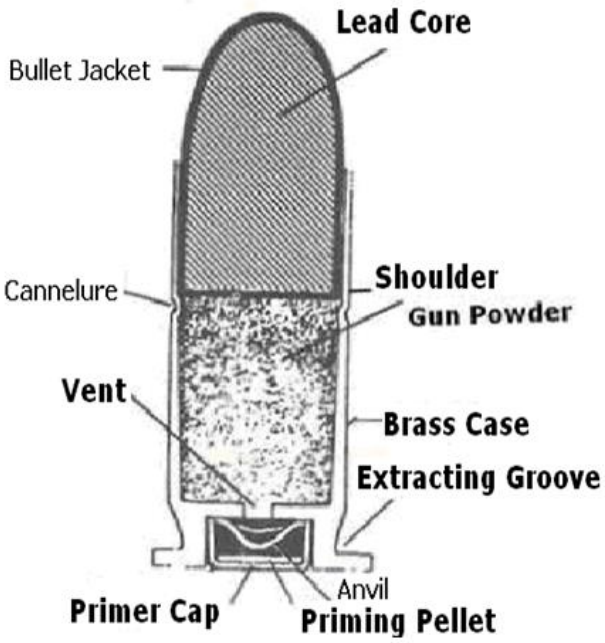
It provides housing for various components of cartridge. It is usually made of brass for rifle, pistol and revolver. For shotgun it is made of card board the base of which is made of brass. Plastic cartridges are also manufactured.

Metallic cartridges have the following components

i) metallic cartridge case or shell

ii) Percussion cap or primer

iii) propellant or gun powder



SCHMATIC DIAGRAM SHOWING THE COMPONENTS OF A METALLIC CARTRIDGE

Shot gun cartridges have the following components

i) paper cartridge case or shell
ii) Percussion cap or primer
iii) propellant or gun powder
iv) spherical balls or lead pellets (shot)
v) over shot wad, under shot wad, air cushion wad and over powder wad

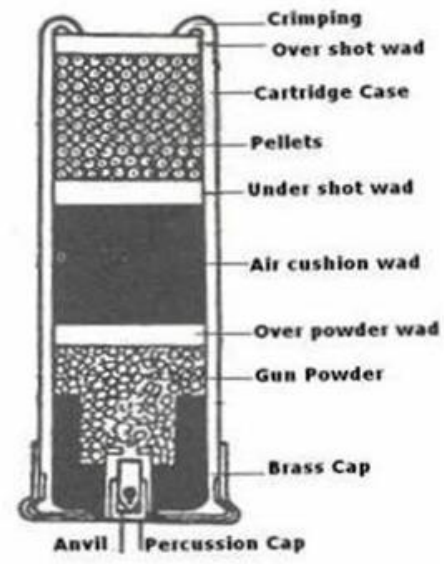


FIGURE SHOWING THE COMPONENTS OF 12 BORE CARTRIDGE

The base of the cartridge case may be rimmed or rimless. Rimmed cartridge helps in positioning the cartridge correctly in the chamber and facilitates extraction. The rimless cartridges are used in pistols and other automatic and semi-automatic firearms. A cartridge case may be rim- fire or centre-fire type. In the rim-fire cartridge, no separate primer cap is provided. The primer composition is located in the rim itself. Whereas, in the centre-fire cartridge, the percussion cap containing the primer mixture is situated in the centre of the base of the cartridge case.

Primer Cap

This contains mercuric fulminate or lead Azide, which is a very sensitive chemical mixture and when the firing pin strikes on it, it gives rise to a hot flame.

Propellant

The powder charge gets ignited through primer and converts into gas at a very rapid rate. The generated gas, under compression, develops pressure in the cartridge and finally forces out of the barrel propelling the projectile. Three types of propellant charges are known:

- Gun powder (black powder): This consists of potassium nitrate, charcoal and sulphur the ratio of 75:15:10.
- Smokeless gun powder: The basic components of these powders are Nitroglycerine and Nitrocellulose (gun cotton).
- Semi-smokeless powder: It is a mixture of Nitrocellulose and black powder in the ratio of 20:80.

Wads

Wads are essential components of shot gun cartridge. Wads are used in the cartridge primarily to keep the propellant and shot charge in their respective positions. In addition they seal the barrel to prevent escape of gases and, consequently, their respective reduction in velocity. In shotgun cartridges, a number of wads are used viz., over powder wad, cushion wad, undershot wad and overshot wad.

Projectiles

- In shotgun cartridges the projectiles consists of small lead balls or pellets. These pellets are of different size, denoted by numbers and the larger pellets by letters e.g. number 1 and 4 contain 100 and 170 pellets respectively; LG and SG contain 6 and 8 pellets respectively.
- In rifles, revolvers and pistols the projectile consists of a single bullet, which fits the bore size. Bullets are made of lead, alloyed with tin or antimony. High velocity bullets have a jacket made of copper, cupro-nickel alloy or steel. Core of such bullets is composed of lead alloy. The bullets are made in various shapes and forms. They may be streamlined, boat tailed or with a flat base. The nose may be flat, round or pencil nose, the size may be short, medium or long.

4.4 MECHANISM OF FIRING

- When the trigger of a firearm is pressed, it releases the hammer or the striker with considerable force. The striker compresses a pressure sensitive material contained in the percussion cap. This generates a hot piercing flame, which ignites the propellant charge. The charge quickly transforms into gas. Due to limited space in the cartridge, the large volume of gas so produced develops a very high pressure. The pressure so developed forces out the bullet or the shot charge through the barrel towards the target.
- While the bullet moves forward the cartridge case is pushed backward. The case, therefore, comes in contact with the firing pin and the breech face of the breechblock, and picks up marks from their surface.
- The cartridge which also expands all round due to the tremendous pressure developed in it comes in intimate contact with the chamber and sometimes may carry chamber marks. The fired cartridge case is extracted out of the chamber by an extractor and then ejected out of the gun by an ejector. In the process both extractor and ejector are likely to leave marks on the cartridge case.
- All these marks are very useful which can afford identity of the bullet or the cartridge case with the concerned firearm.

4.5 IDENTIFICATION OF FIREARMS

In order to link the weapons recovered from the suspect, it has to be established that from the crime weapon the cartridge cases and bullets recovered at the crime scene were fired / discharged. The crime weapon will be test fired loading it with the cartridge of the same make by firing into a bullet recovery box filled with cotton to obtain bullet bearing marks characteristic of the barrel. The test cartridge case and test bullet are thus obtained.

The following aspects are to be noted before one can arrive at an identification of a firearm

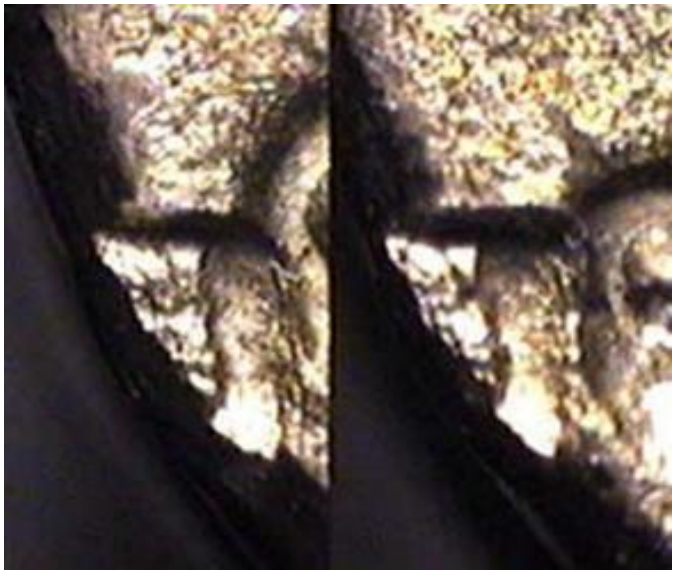
i) Whenever a hard object acts on a soft object, the hard object leaves its own individual characteristics on the soft object.
ii) All objects acquire some peculiar characteristics due to usage, wear and tear, maintenance and user's peculiarities and so on. No two firearms will leave identical individual characteristics on the cartridge cases.
iii) Therefore the bullets fired and discharged from firearms invariably possess the characteristics marks of the firearms used to fire the ammunition.

The crime cartridge case and test cartridge case are examined and compared under comparison microscope and the following marks are examined.

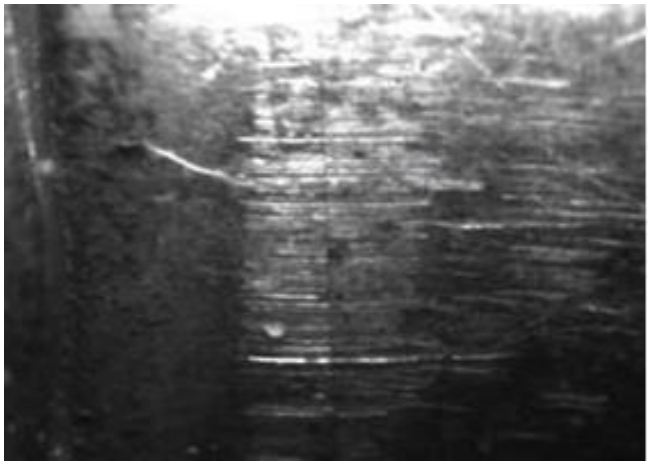
i) *Breech Face Marks:* At the moment of the firing the base of cartridge case strikes with a tremendous force on the breech block there by the impressions on the breech block will be registered on the base of the cartridge case. These breech face marks in test and crime cartridge cases are compared.

ii) *Firing Pin Impressions:* Because the firing pin strikes the primer cap with force, there will be marks of firing pin on its surface. These firing pin marks are different for different firearms and are rarely or never duplicated.

iii) *Extractor and Ejector Marks:* Most of the firearms possesses extractor or ejector or extractor cum ejector. These impress on the rim of the cartridge case in definite and recognizable marks like size, shape and location.



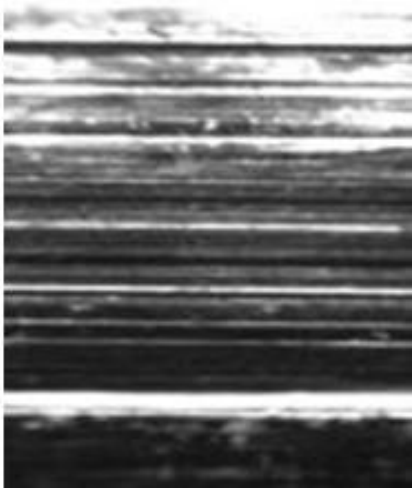
iv) *Chamber Marks:* At the time of firing, the cartridge case expands and may take up marks or certain irregularities of the chamber.



4.6 BULLET IDENTIFICATION

Bullets collected for comparison to a specific firearm are examined first to see if they are of a calibre that could have been fired from the submitted firearm. They are then examined to determine if the pattern of rifling impressions found on the bullet match the pattern of rifling contained in the barrel of the questioned firearm. If these class characteristics agree the next step is to try to make a positive match between the individual characteristics that may have transferred to the bullet from the barrel.

Located within the rifling impressions on a bullet can be microscopic striations or scratches like those seen on the bullet below.



Imperfections in the surface of the interior of the barrel leave striations on the projectiles. Striations have the potential to be consistently reproduced in a unique pattern on every bullet that passes down the barrel of a firearm.

Bullets fired through rifled firearms receive both the class as well as individual characteristics of the barrel from which they are fired. The bullet will show not only the primary markings left by the lands and grooves of the rifled barrel but will also reveal the fine striations in all the marks. These are the imprint of the small irregularities in the barrel, and are never duplicated by different weapons. To determine whether or not a particular firearm has fired the questioned bullet, a

detailed comparison is made of markings on the question bullet with corresponding markings on the test bullets fired through the suspected weapon. A comparison microscope is used for this determination.

4.7 DIRECTION OF FIRE

The direction of fire can be of great help in the reconstruction of the events in the firearm offences. It may help to find out whether the incident is suicidal or accidental firing. The direction of fire can be ascertained by the shape and nature of entry wound. The systematic study of the bullet hole at the point of entry, its path and the point of its location in the body or the exit wound may help establish the direction of fire.

4.8 RANGE OF FIRE

Range is the distance between the muzzle end of the barrel and target and can be estimated by studying the following:

i) Close Range Firing Effects:

a. *Burning / Scorching*: When a projectile leaves the fire arm, the gases also come out at very high temperatures. When the gases combine with oxygen of the atmosphere a flame is produced which extends up to a few inches. If the weapon is close to the target, this flame produces burning or scorching or charring of the target. Burning may occur up to a distance of 6‰ in case of service rifle or 12-bore shot gun, whereas in hand guns it is up to 2 to 3‰ only.

b. *Blackening:* the propellant gases consisting of carbon particles are deposited around the wound and produce blackening. This blackening can be easily wiped off because it is merely the deposition of carbon particles around the wound. However, the blackening due to burning cannot be wiped out. In case of service rifles or shot guns blackening may occur up to a distance of 12‰, and up to 6‰ in case of hand guns.

c. *Tattooing*: Deposition of un-burnt and partially burnt propellant around the projectile hole is called tattooing. If the entry wound is not covered by clothes, these particles may produce contusion. In case of service rifles or shot guns tattooing may be observed up to a distance of 4 feet. In case of hand guns it is up to one foot. Beyond this range it is not possible to estimate the range in case of rifled fire arms. But it is possible to estimate the range up to 2 meters in case of 12 bore shot guns with 12 bore KF special cartridges. The shot charge discharged from 12 bore shot guns makes a single hole, up to a distance of (range) 2 meters.

Range at	Diameter of the Single hole
30 cms	2 cms.
1 meter	3 cms.
2 meters	4 cms.

At a distance of two meters the individual pellets start separating from the main charge. This is called cookie cutter etching. At 2 to 5 meters distance a rat hole is formed, i.e., a central hole surrounded by several holes caused by the penetration of the individual pellets. The diameter of the central hole varies from about 2 to 6 cms.

ii) **Shot Patterns:** At close ranges, the shots emerging from the barrel travel with considerable force in a closely held group. The wads also get associated with the shot group up to a few meters from the muzzle. The wads soon begin to loose their velocity and get dropped. The shots progressively separate and spread out. As the range increases, the shots may spread to cover a wider area but will have little force. Because of this progressive change in the shot and wadding pattern, it is possible to determine with considerable accuracy the distance of firing. The pattern, however, must be available for study and the concerned weapon and ammunition must be obtained for test firing. The same gun and the same kind of ammunition are used to test fire at different measured ranges to match with the pattern revealed in firearm offence under investigation.

iii) **Wad Distribution:** A number of wads are found in shotgun ammunition. They are propelled along with the other charge. They may enter the target up to about three meters. If they do not come across any obstruction they can travel up to the five meters. If the distance between the victim and the wads is known, the range of fire may be determined.

iv) **Muzzle Pattern:** When a firearm is fired in contact with the target, an imprint of the muzzle is left on the target. In such wounds the whole charge will enter into the target. No burning, blackening and tattooing are observed around the entrance hole. Often the entrance hole will bear a tear on the cloth or skin in the form of a cross.

4.9 DETECTION OF RESIDUES ON HAND

When a firearm is fired, especially a revolver, powder residue from the propellant and the primer may be blown through the cylinder. Traces of such residues are sometimes transferred on the hands of the shooter. Detection of such residues helps the investigator in identifying the fire.

A variety of methods have been in practice for some time. Walker devised a test known as

Walker test. It was developed to detect nitrite in the residue using desensitized photo bromide paper. Another spot test called Paraffin test was also developed to detect dermal nitrate on the hand of the firer.

The hand washings of the suspected firer is obtained by thoroughly washing his hands with warm water and subjected to the above tests.

Another modern method is by utilizing *SEM-EDX*. The suspected gunshot particles on the hands of the shooter are collected by means of a specialized GSR collection kits which contains stubs, gloves, plastic containers etc. The forefinger and its

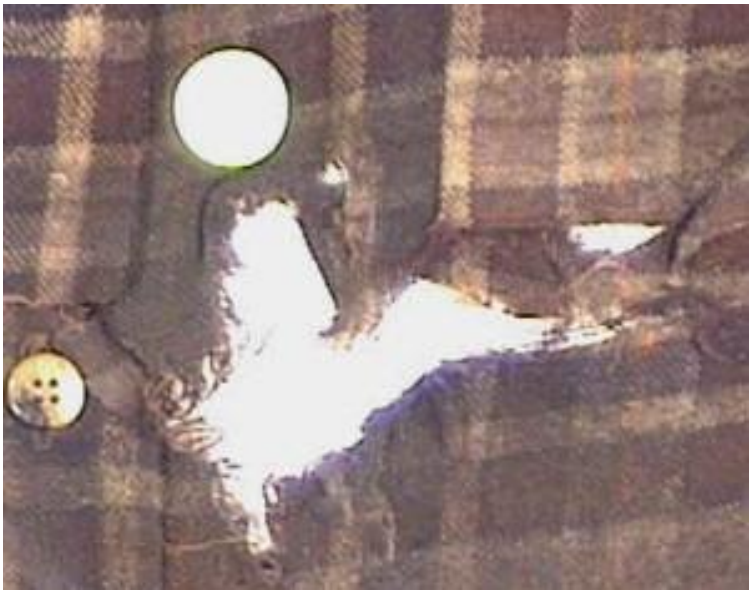
adjoining area, the palm are pressed with stubs after which the stubs are packed taking all the legal formalities. The stub is analyzed under SEM-EDX for gunshot residue.

4.10 GUN SHOT RESIDUE

When the bullet exits the muzzle, pressure behind it blows the gunshot residues out of the firearm's barrel under high velocity. The residues are expelled from the barrel in a smoky cone shaped pattern. The further gunshot residues travel from the muzzle, the broader and less concentrated the pattern becomes.
The muzzle-to-garment distance can vary considerably depending on the firearm and type of ammunition being used. Short-barrelled firearms and lower velocity cartridges will not normally expel residues as far as a high velocity rifle. At shorter distances however, they may deposit greater concentrations of gunshot residues. Also, gunpowder can come in several forms such as ball, flake, disc, and others. Ball powder being spherical in shape is more aerodynamic than say a particle of flake gunpowder and as a result will travel farther.
Gunshot residues emitted from the muzzle will travel out to distances of approximately 3 and 5 feet in most firearms but in some cases can travel even greater distances. At the 3- 5 foot range the gunshot residues may only consist

of a few trace particles and make determining the firing distance difficult if not impossible.
As the firearm gets closer to its target the residue concentrations increase and the actual size or diameter to the pattern gets smaller. At around 18-24 inches most firearms will start to deposit considerable concentrations of gunshot residues that may or may not be visible to the eye.
At distances of less than around 12 inches heavy concentrations of visible gunshot residues will normally be deposited.

When the muzzle of the firearm gets next to or is in contact with the target, hot gases escaping from the muzzle at high velocity will typically rip, tear, shred, and/or melt the material of the target. A very intense deposit of gunshot residues will be found around the margins of a contact or near contact entrance hole.



Gunshot residue is normally a combination of *gunpowder residues* and *lead residues.* Gunpowder residue can contain unburned gunpowder particles, partially burned gunpowder particles or the carbonaceous soot from completely burned gunpowder.

Gunpowder particulate residue around bullet entrance hole.

Modern smokeless gunpowder, and black powder, contains *nitrate* compounds. When either of these types of gunpowder burns the residue left behind will be in the form of a *nitrite*-based compound. Nitrite particles when emitted from the muzzle of a firearm will strike a nearby target and either be imbedded in the target's surface or leave a deposit of nitrite residue.

Lead residues will be in a vaporous or particulate form and can come from a couple sources within a discharged cartridge. The most common source is the *primer.*

As described above, gunshot residue can be deposited on articles of clothing when in close proximity to a discharged firearm. In most cases the gunshot residue can be detected.

The various elements contained in gunshot residue are not readily water soluble and

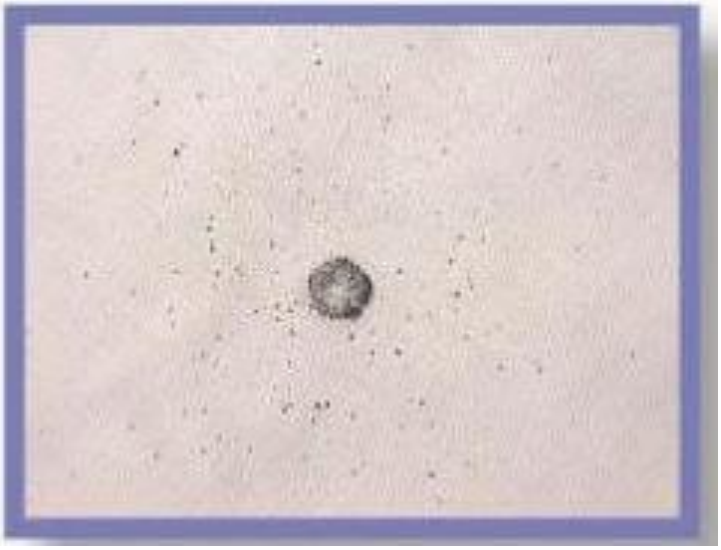
clothing left exposed to the elements will not usually diminish the residue deposits. Other factors such as heavy bleeding and rough handling of the garment can cover up or dislodge some residues. This has to be taken into consideration when conducting all such examinations. The garments must be promptly collected, allowed to air dry, and packaged in a way that will minimize contamination.

Clothing submitted to the laboratory will be examined to determine if a *pattern* of gunshot residues are present. There are basically three steps taken by the firearms examiner to process an item for the presence of gunshot residue.

The first step is to visually and microscopically examine the evidence. The presence of any gunshot residues found around the bullet hole as well as the shape and appearance of the hole will be documented.

The next two steps involve chemically processing the exhibit for gunshot residues.

The first chemical test conducted is called the *Modified Griess Test*. The Modified Griess Test is performed first on the exhibit because it will not interfere with later tests for lead residues. The Modified Griess Test is a test to d etect the presence of *nitrite* residues.



The last test conducted on the exhibit is called the *Sodium Rhodizonate Test*. This chemical test is designed to determine if *lead residues* are present on the exhibit.

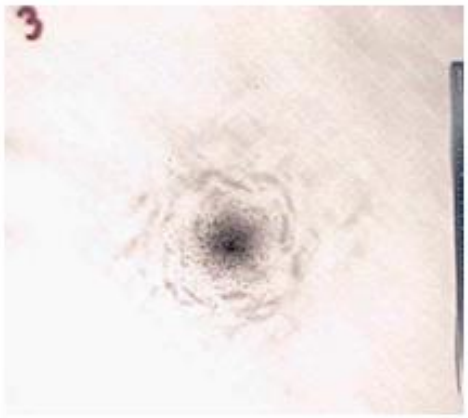
4.11 DETERMINING THE RANGE OF FIRING BY STUDYING THE GSR PATTERN

Gunshot residue distance standards are made by firing the firearm, using ammunition like that used in the actual case, into witness panels that consist of white pieces of cotton twill cloth. Seen below are three witness panels attached to a frame for display purposes.

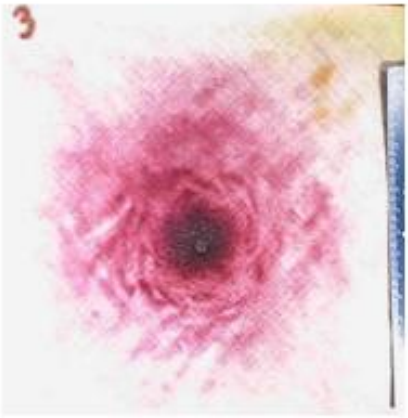
Several panels will be fired into at varying distances. There are really no set distances but an example would be to fire at distances of Contact, 6, 12, 18, 24, 30, and 36 inches.

The distance tests standards are processed in the same way the exhibit was processed. The Griess Test is conducted and the witness panels are chemically treated for the presence of lead residues. The resulting residue pattern standards are used to estimate the muzzle-to-target distance.

Below are examples of distance standards that were fired at distances of 3, 15, and 27 inches using a Ruger Security-Six revolver and 38 SPECIAL cartridges containing plain lead, round-nosed bullets.



3 inch witness panel



3 inch witness panel processed for lead residues

3 inch Griess Test results.

15 inch witness panel (unprocessed)

15 inch witness panel processed for lead residues

15 inch Griess Test results.

27 inch witness panel (unprocessed)

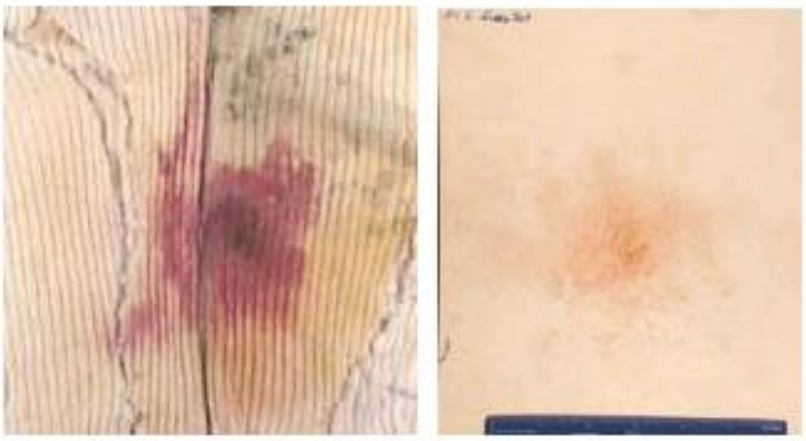
27 inch witness panel processed for lead residues

27 inch Griess Test results

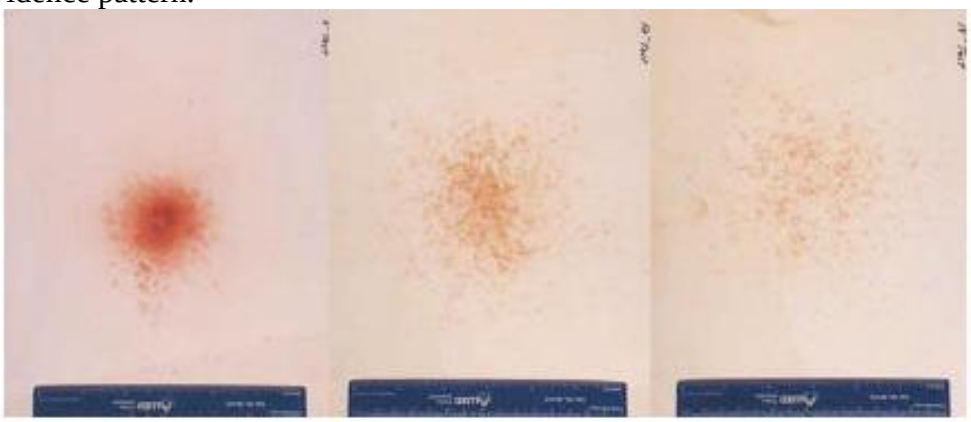
Once standards, like those seen above, are produced they are compared to the residues found on the victim's clothing.

The image on the left below shows a shirt that has a bullet entrance hole in the front chest. It has been processed for nitrite and lead residues. The image on

the right below shows the results of the Griess Test and the pink seen on the shirt is a very heavy deposit of lead residue.



Below are the results of three Griess Tests standards, made at 3, 12, and 18 inches. The 3-inch standard shows a nitrite deposit considerably more concentrated and smaller in diameter when compared to the evidence pattern. In addition, the 18-inch Griess Test standard shows a broader and less concentrated pattern than that seen on the evidence pattern. The 12-inch Griess Test standard is very similar to that seen on the evidence pattern.



The muzzle-to-garment distance would then be reported as *greater than 3 inches but less than 18 inches*.

When no residues are found around a bullet hole, it can mean several things.

1. The firearm was at a distance far enough away that the residues did not reach the garment.
2. An intervening object between the firearm and garment preventing the residues from reaching the garment.
3. Gunshot residues were removed through severe handling, heavy bleeding, or by some other means.

There will also be times when only trace deposits of gunshot residues are found. Trace amounts of gunshot residues can come from any number of sources. Prior handling or firing of a firearm or being near a firearm that was discharged are just a couple possible sources.

4.12 ENTRANCE & EXIT WOUND

4.12.1 Entrance Wound

Entrance wound is recognized by its inverted margins, the presence of scorching, blackening, tattooing, dirt ring, size and the number of wounds. The inversion of the edges at the entrance is caused by the projectile, which draws the skin inside. The dirt-collar and contusion ring are often noticed on the entrance side of the wound. The dirt ring is formed by the deposition of graphite, grease and dirt present on the bullet. The contusion ring is due to the impact of the projectile on the surface around the wound. When the muzzle of the gun is held in contact with the skin, the surface may be torn and lacerated, and powder marks on the surface may be entirely absent, due to their having entered the wound. Marks or imprint of wads may be found at the entry of a shotgun injury. The diameter of the entrance wound is usually smaller than the diameter of the bullet. This is due to the elasticity of the skin. The shape of the entrance wound may be round or oval. When the projectile enters the body at right angle to the surface, usually a round hole is formed. If it enters at an angle, an oval shaped hole is formed.

4.12.2 Exit Wound

Exit wound is recognized by the absence of various marks found around the entrance wound such as presence of inverted edges of the skin and the shape and size of the wound, close range firing effects such as burning / scorching, blackening, tattooing around the wound. The edges of the wound are averted.

The size of the exit wound is generally larger than the entrance wound or even size of the projectile. This is due to the deformation of the projectile and the tissues it gathers around it. There may be more than one exit holes for one entrance wound, especially when a bone has been struck, pieces of bone may be put into motion or the bullet may get fragmented. The bleeding is much more at the exit wound.

4.13 HANDLING, COLLECTION AND PRESERVATION OF EVIDENCE

- The firearm found at the scene of crime should not be touched until its position has been photographed, sketched and marked. If a firearm is found on the floor, any marks on the floor caused by it must be examined. If the deceased person is holding the firearm, it is important to note the exact grip and the position of the firearm in his hands. In the case of guns or rifles, the possibility of the deceased having fired the shot at him should be carefully investigated. Strings or sticks laying nearby may give an indication of their having been used by the victim to pull the trigger.
- The position of the cartridges, cartridge cases and bullets is equally important. From their position it is possible to deduce the position of firing, the direction of shot and, in certain cases also the path of the bullet. The presence of a cartridge case at the scene may indicate the type of firearm used in the offence. The position of wads and over-shot wads, from shot gun cartridges and muzzle loading weapons also give information relating to the bore of the gun, the direction of shooting, the make and type of cartridge, the shot size number and nature of powder used in it. Great care should be taken in collecting and packing bullets and cartridge cases so that

microscopic marks left by the firearm are not damaged or destroyed.

- When lifting a pistol or revolver the best way is to hold it with two fingers on the butt, or by the ring of the butt. Guns may conveniently be held by the sling or sling swivels, or if necessary, by a steady grip with the fingers on the trigger guard. Do not lift a firearm by placing a stick or similar object in the trigger guard, as the firearm may be cocked.

The muzzle of the firearm should never be pointed against anyone. Do not lift the firearm by putting a stick or pencil in the barrel, as this might destroy useful clues inside the barrel. No firearm should be sent for examination in a loaded condition. The magazine in automatic pistol is likely to bear fingerprints. While unloading, care should be taken to preserve the fingerprints.

4.14 NATURE OF EVIDENCE RECEIVED BY BALLISTICS SECTION

In FSL, nature of examinations conducted and type of analytical information laboratory can provide is given below:

Sl. No	Nature of Physical Evidence	Nature of examination conducted	Type of analytical information laboratory can provide
1.	Firearms	1. Physical examination 2. Test firing 3. Chemical examination 4. Chemical Etching Method	Whether it is company made or country made? What is its bore/calibre What is the make and model Whether it is prohibited or not? Whether the firearm is in working order, if not what repairs are required Whether the firearm is prone to accidental discharge What is its effective range? Whether recently used for firing? What type of gunpowder is used? If any erased markings are present to restore the original markings.
2.	Ammunition	1.Physical examination	What is its caliber/bore? Whether it is company or country

	a) Cartridge	2.Chemical examination	made? What is its shot size number? Whether it is live or not? Through which weapon they can be fired? Whether it is reloaded or not? What type of gunpowder is used?
	b) Empty cartridge case	1. Physical examination 2.Microscopic examination (i.e. firing pin mark, breech face mark, extractor & ejector marks and chamber marks) 3.Chemical examination	What is the calibre/bore? From which type of weapon it was fired? Whether the empty cartridge cases were fired or not.
	c) Bullets	1. Physical examination 2. Microscopic examination (Rifling marks i.e., lands grooves, twist etc. and striation marks.	What is its caliber? Whether the bullet was fired or not? Whether it was fired from a company made or country made firearm?
	d) Pellets and wads	1. Physical examination 2. Chemical examination	What is the shot size number What is the size of the bore? How many no. of cartridges were fired? What is it's make? What kind of gun powder was used to propel the pellets & wads?
3.	Firearms along with empty cartridge cases & fired bullets	1.Under comparison microscope	To ascertain whether the empty case/bullet was fired from the firearm seized from the culprit.

4.	Clothes and skin pieces containing holes	1. Physical examination and under IR light 2. Chemical examination 3. Instrumental methods of analysis	How many no. of firearms were used? How many no. of shots were fired? What is the range of firing? Whether the holes are entry /exit/multiple entry by one bullet or not? What type of gun powder was used for firing? Whether the rents were caused by the lead projectiles or copper jacketed bullets etc?
5.	Postmortem certificates	1. Study	What was the range of fire? What was the angle of fire? Whether the wounds were entry or exit ? How many no. of shots/bullets were fired?

4.15 PRECAUTIONS & GUIDELINES

- In case of a crime scene involving firearms all possible evidence such as firearms, empty cartridge cases, live cartridges, bullets, pellets, wads, gun powder and gunshot residue should be recovered after properly recording and photographing the position of each item.
- ***Firearms in loaded condition should not be sent to Forensic Science Laboratory.*** If there is any difficulty in unloading the firearm the services of the ballistics expert has to be requisitioned. In extreme cases where the firearm has to be sent in loaded condition, the safety catch of firearm should be kept in safe mode and the constable who carries the case property should be informed about the loaded condition of the firearm and the parcel should be marked with red letters Handle With Extreme Caution – Firearm Is In Loaded Condition.
- The firing pin of the firearm should be protected with cotton before packing the firearm.
- Empty cartridge cases and bullets should be packed separately in cotton.
- Live cartridges should be packed in a wooden/card board boxes with proper padding.
- Blood stained clothes and wads should be dried in shade and then packed separately taking due care not to disturb the gunshot residue.
- While recovering bullets lodged in furniture, walls etc care should be taken so that the rifling marks on the bullets are not disturbed.

GLOSSARY:

1. Bore
2. Breechblock
3. Caliber
4. Choke
5. Distance determination
6. Ejector
7. Extractor
8. Firearms identification
9. Gauge
10. Greiss test
11. Grooves
12. Lands
13. Rifling

LEARNING OUTCOME

After studying this unit you should be able to:

1. Understand the importance of Forensic Ballistics.
2. Classify Firearms.
3. Understand and recognize the various parts of Firearms.
4. Identify a specific bullet by performing various comparison methods.
5. Understand the direction of fire and its range.

SUGGESTED READINGS

1. Firearms Investigation - Hacher.
2. Firearms Investigation and Trials - B. R. Sharma.
3. Handbook of Fire Control and Protection - A. Kumar.
4. The Ultimate Book of Weapons - N. C. Asthana.
5. Firearms & Forensic Ballistics - Gaur's.
6. Arms & Explosives Acts & Rules - Mukherjee.
7. Gunshot Wound - Dimao.
8. Handbook of Firearms and Ballistics - Brian. J. Heard.
9. Terminal Ballistics, A Text and Atlas of Gunshot Wounds - Malcolm. J. Dodd.
10. Firearms, the law and Forensic Ballistics - Tom Warlow.

UNIT V

LEARNING OBJECTIVES

In this unit you will be introduced to:

1. The different properties of Glass.
2. Evaluation techniques and methods of Glass fractures.
3. Collection and Preservation of Paint.
4. Various Guidelines and precautions in collection of different samples.
5. Nature of Marks.

UNIT V- FORENSIC PHYSICS

5.0 INTRODUCTION

The forensic physics deals with the examination of physical characteristics of evidence such as surface characteristics, morphological features and other physical characteristics, such as length, weight, volume, shape, size, density, pattern etc.

The following types of physical evidence are generally examined in the physical examination section.

i) Glass in the form of piece, particle, fragments etc.

ii) Soil, duct, mud, debris and other related materials

iii) Paint in the form of flakes, chips, smears and in raw form

iv) Tool marks

v) Substandard/spurious manufactured materials like cement, talcum powder, soaps, weights and measures

vi) Counterfeit currency

vii) Gems, precious stones & other natural minerals

viii) Imitation/fake jewellery/ornaments

ix) Seals, stamp impressions

x) Printed matter such as labels

5.1 GLASS

Glass, or glass fragments may be of great value in the investigation of any criminal offences such as burglary, arson, hit-and-run accidents, shooting, assault and others. In some cases the breaking of glass during the commission of an offence may be the result of an intentional act; in others, it may be the result of an accident. In either type of situation, glass fragments may get lodged in the implement used in the offence.

5.1.1 Properties of Glass

Glass is hard, brittle, amorphous substance obtained by fusing a mixture of silica and two or more alkaline bases, such as soda, lime or potash.

5.1.2 Collection and Handling

Methods used in the search and collection of glass and glass fragments are usually the same as those used for other types of evidence. The evidence of glass must be photographed and their location noted on the sketch before they are touched or moved.

While collection glass or glass fragments, fingerprints, dust or dirt, bloodstains, or other foreign matter should be well protected. All available fragments should be collected, to provide as complete a reassembly as possible.

Shattered or broken glass may provide a clue in the identification of a suspect. The particles of fragments of the glass may lodge in or adhere to the clothing of the perpetrator or fall into his pockets or trouser fold. Collecting of such fragments for

comparison with glass found at the crime scene is a worthwhile effort. The soles of shoes should not be overlooked in the search for this type of evidence.

A thorough search of the broken glass pieces in a hit-and-run accident may be extremely useful. Fragments of glass may be found adhering to or embedded in the tyres of the suspected vehicle.

The control glass should always be taken from any remaining glass in the window or door frames, as close as possible to the point of breakage.

5.5.3 Evaluation of Glass Fractures

Glass bends when a force is applied on any one of its surfaces. When its elasticity limit is reached the glass fractures. Following characteristics are observed in fractured glass:

i) Radial Fractures: The penetration of glass by a projectile, whether it is a bullet or stone, produces a characteristic fracture pattern. The cracks, which radiate outward from the point of impact, are termed as Radial Fractures. The Radial Fracture originates on the surface opposite to that on which the fracturing blow or force was applied.

ii) Concentric Fractures: As the original breaking force is continued, another force acting in the opposite direction caused the glass to break in secondary fractures, and these are termed as concentric fractures. Concentric fractures are in the form of a series of broken circles around the point of impact. These fractures originate from the opposite side of the radial fractures.

iii) Cone Fracture: A high velocity projectile, such as a bullet, when penetrates the glass, leaves a round crater shaped hole which is surrounded by radial and concentric cracks. The hole is wider on the exit side and gives the appearance of a cone and hence termed as cone fracture.

iv) Rib or Stress Lines: The edges of broken pieces of glass bear a number of curved lines, termed as stress lines. These stress lines are tangent to one side of the glass and perpendicular to the other. They are always perpendicular to the side that breaks first. In radial fractures, the stress lines are perpendicular to the side opposite from which the blow was struck. In concentric fractures, they are perpendicular to the side on which the blow was struck. A convenient was for remembering these observations is the 3 R rule – Radial cracks form Right angle on the Reverse side of the force.

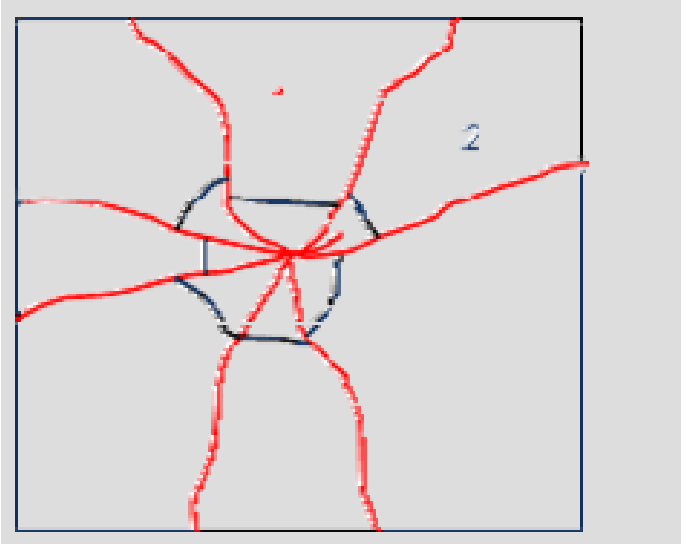


Fig 1: Showing radial (2) fractures and concentric (1) fractures.

5.5.4 Sequence of Holes in Glass

When there are two or more bullet holes in a pane of glass, it may be possible to determine which hole was made first. A radial fracture in glass travel for some distance, depending upon the force of impact, but if it meets another fracture that has been formed earlier, it will terminate at that point. Consequently, if fractures from one bullet hole are stopped by those made by another bullet hole, it may be deduced that the latter was first.

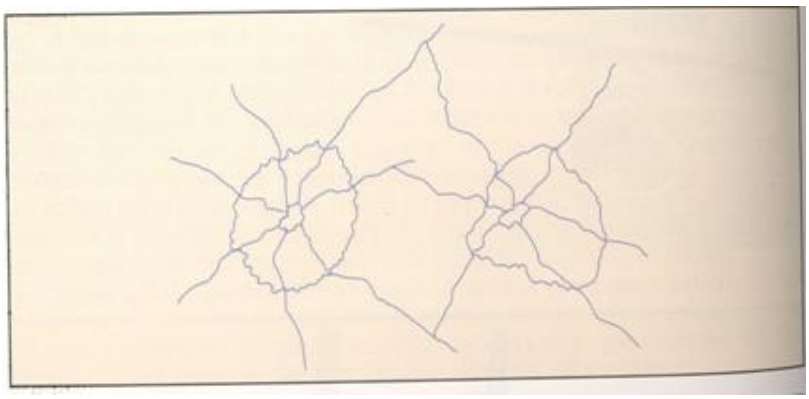


Fig 2: The left hole preceded the right hole

5.5.5 Angle of Impact in Glass

The angle at which a projectile enters glass may be determined by the amount of chipping on the exit side. If a bullet strikes glass at right angles to the surface, chipping around the exit hold will be evenly distributed making a symmetrical hole.

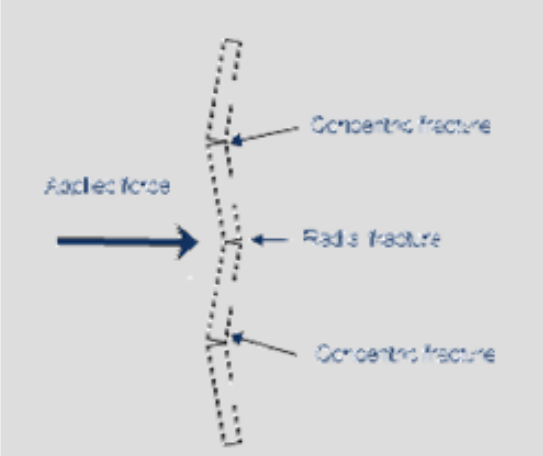


Fig 3: Formation of radial and concentric fractures

5.5.6 Fractures Caused by Blunt Object

Glass fracture caused by the impact of blunt object will reveal a pattern of radial and concentric fractures similar to, but not as regular as, the pattern caused by a bullet.

5.5.7 Fractures Due to Heat

Fractures in glass that are formed due to excessive exposure to heat do not show a regular pattern of radial and concentric lines, but are irregular wavy shaped pattern.

5.5.8 Backward Fragmentation

When a sheet of glass is broken, although most of the glass fragments travel in the direction of the force, many fine chips also thrown backwards. These fine chips fly with considerable force because of great compression on the side of impact and may impregnate the clothing's of the perpetrator.

5.5.9 Details of Information FSL can provide on the Examination of Glass Pieces & Fragments; Glass Panes with Fractures

Nature of Physical Evidence	Nature of Examination Conducted	Type of Information that can be Provided
Glass Pieces & Fragments	a. Physical b. Physical Matching c. Microscopic d. Fluorescence	i. Whether the given fragment did or did not originate from a particular glass object?

	e. Density analysis f. Refractive Index g. Elemental analysis	ii. Whether a fragment originated from a particular glass object, such as a headlight glass, windowpane, spectacle lens etc.? iii. Whether a fragment of glass has come from a particular region of the broken glass object? iv. Can the origin of fracture, its direction, and the direction of the force producing it may be traced from a larger glass fragment? V. The angle from which projectile struck a glass object?
Glass Panes with Fractures	Physical	Determination of the direction of force, sequence of fractures etc.

5.5.10 Guidelines and Precautions in Collection of Glass

- The evidence of glass must be photographed and their location noted on the sketch before they are touched or moved. The fragments or fall in his pockets or trouser folds, shoes etc, should be searched/collected.
- While collecting glass or glass fragments, fingerprint, dust or dirt, blood stains, other foreign matter should be well protected.
- All available pieces, fragments should be collected to examine the commonness of source of origin.
- Control glass should always be taken from any remaining glass in the window or door frames, as close as possible to the point of breakage.
- Fragments of glass, which may be adhering to or embedded in the tyres of the suspected vehicle, should be collected.

5.2 PAINT

Paint as protective coating is applied on buildings, vehicles, equipment and millions of other objects, traces of which may get removed or transferred during the commission of crimes. Paint, as evidence is usually associated with burglaries, hit-and-run cases and other crimes involving the use of vehicles.

5.2.1 Nature of Paint

Paint is a viscous, opaque, white or colored liquid mixture which when spread on a surface, will dry into a hard film. The hard film will consist of pigments

suspended in a binder. Pigments impart color to paint, and are usually mixtures of different inorganic and organic compounds. The binder provides the support medium for the pigments. Other materials for increasing the bulk are also added. All these are added to a suitable solvent, which evaporates off when the paint is applied to the source.

Paint is generally recovered in the form of chips, smears or intact paint. Chips result from old paint; smears from either fresh paint or due to „chalking‰ effect of the old paint, intact paint is found adhering to painted objects.

5.2.2 Collection and Preservation of Paint

Paint chips are most likely to be found on or near persons or objects involved in hit-and-run accidents. The recovery of loose paint chips from a garment or from the road must be done with utmost care to keep it intact. Small plastic and cardboard containers make excellent containers for paint. If the paint is smeared on objects, it is best to carefully pack the seized item itself and sent for laboratory examination.

In automobile accidents involving two cars there is usually a transfer of paint between them, which may definitely establish that the two vehicles had come in contact. The transferred paint should be collected on a clean piece of paper, and then placed separately in a suitable container.

When a transfer of paint occurs in hit-and-run accident, it is important to collect uncontaminated control sample from near the surface of the vehicle suspected of being in contact with the victim or his vehicle. Control sample should also include all the paint layers down to the base metal. This can be collected with a clean scalper of a knife blade. Each paint sample should be separately packed indicating the exact location of its recovery.

5.2.3 Details of Information FSL can provide on the Examination of Paint Flakes, Chips & Smears

Nature of Physical Evidence	Nature of Examination Conducted	Type of Information that can be Provided
Paint: Paint Flakes, Chips and Smears	a. Physical b. Physical Matching c. Microscopic d. Reaction to solvents e. Pyrolysis Gas Chromatography f. IR Sectrophotometry elemental analysis	Whether the two paint samples originated from the same source or not.

5.2.4 Guidelines and Precautions in Collection of Paint

1. When transfer of paint occurs in hit and run accident, uncontaminated control sample must always be collected from near the surface of the vehicle as was suspected of being in contact with the victim's vehicle with the help of a clean scalpel or a knife/blade.
2. Control sample should also include all the paint layers down to the base metal.
3. Loose paint chips from a garment or from the road must be collected carefully and should be packed in small plastic containers.
4. Each paint sample should be separately packed and marked as to the exact location of its recovery.

5.3 SOIL, DIRT AND DUST

5.3.1 SOIL

Soil is present at every scene in one form or the other and is usually collected as a heterogeneous mixture, which may include clay, sand, rock, coal, plant material and other debris. In many cases soil is either deposited at or carried away from a crime scene. It may be found on the suspect, his shoes, his clothing, his vehicle or tools used in the crime. It may be found at the scene of hit-and-run accident where the soil present on the under carriage of the vehicle may have fallen due to impact.

5.3.1.1 Nature of Soil

The term soil may include any disintegrated surface material, both natural and artificial, that lies on or near the earth's surface. It is formed from rocks and minerals by the weathering process and later it gets pulverized with plant, animal and manufactured products. Soil, therefore, encompasses not only the naturally occurring rocks, minerals, vegetation and animal matter but also includes manufactured materials like glass, paint chips, asphalt etc., which may impart soil with characteristics that will make it unique to a particular location. Further variations in soil are caused by man due to mining, agricultural and industrial operations where there is almost constant mixing and moving of soil.

5.3.1.2 Collection of Soil

When collecting soil, care must be exercised so as not to destroy other trace materials that may be present. If the soil is found adhering to an object, as in the case of soil on a shoe, the I.O. must not remove it. Instead, each object must be individually wrapped in paper with the soil remaining in situ and transmitted to the laboratory.

When a lump of soil is found, it should be collected and preserved as such.

For proper analysis, a control sample of soil be collected from the scene. Samples should be collected as close to the scene as possible. If the comparison samples are taken from a distance of a foot or more, the variation may be too great to establish an identity.

Each sample should consist of about two tablespoonful of soil. In taking a sample, it is seldom necessary to go deeper than ½ to of an inch of the surface. However, if a footprint, tyre track or other indentation in question penetrates into subsoil that is different from the topsoil, it may be necessary to obtain samples of both the

topsoil and the subsoil.

If soil has been found on a suspect's shoes, a comparison sample should be taken from that portion of a footprint, which corresponds, to the part of the shoe on which the evidence was found.

5.3.2 DUST AND DIRT

Dust is usually characterized as being composed of microscopic particles, which cannot be categorized under any specific evidence. Such dust may be very characteristic of a particular place. This applies especially to places such as flourmills, building sites, workshops, coalmines, saw mills and the like. A person who has worked at or visited such a place carries on his clothes dust characteristic of that place and may reveal his occupation or his visit to that place. The evidentiary value of this nature can be of paramount importance, and often a clinching factor.

Dirt on the other hand is a material, which is transmitted or acquired usually by accidental contact, the ingredients of which may have come from a varied source. A typical example of dirt will be the residue from a suspect shoe, which when examined by immersion in water, in a dish, may reveal leaf, vegetable matter, fibers, seeds etc. After separation and drying qualitative analysis may ascertain the nature of the mineral ingredients. The analysis of vegetable ingredients present in the dirt may point to the places visited by the suspect.

5.3.2.1 Collection

Dirt and the specimens are removed from garments by several methods. Large quantities are removed by the usual mechanical means of scrapping and picking off with tweezers or shaking out. Garments may then be placed in clean paper bags and beaten to remove dust or may be collected directly into a filter paper by means of a special vacuum cleaner device.

Dirt in the fingernails is scrapped and collected in a clean paper. Scrapings from different fingernails should be packed separately.

Dust and dirt from pockets and trouser folds should be collected by means of a small clean brush.

Dirt on shoes is best removed not by scraping, which may break up fragile material such as leaf tissue, but by means of water and a soft brush.

Nature of Examination Conducted on Soil, Dust and Dirt.	Type of Analytical information FSL can provide.
a. Physical b. Microscopic c. Particle size d. Fluorescence e. Density F. Elemental analysis	Whether the soil samples have originated from the same location/spot or not

5.3.3 Guidelines & Precautions in collection of Soil

1) Control soil samples should be collected from the upper layer randomly as close to the scene as possible without contamination.
2) Care should be taken so as not to destroy other trace materials that may be present.
3) If the soil is found adhering to an object, as in the case of soil on a shoe, the I.O. must not remove it. Instead the object should be wrapped in a paper with the soil intact and transmitted to the laboratory.
4) When a lump of soil is found, it should be collected and preserved intact.
5) If a foot print or tyre track indentations in question penetrates into subsoil that is different from the top soil then it is necessary to obtain samples of both the top soil and sub soil separately.
6) Dirt in the fingernails has to be scrapped and collected in a clean paper. Scrapings from other fingernails should be packed and sent as control samples.
7) Dust and dirt from pockets and trouser folds should be collected by means of small clean brush.

5.4 RESTORATION OF OBLITERATED MARKS

Manufacturers of valuable items, like automobiles, firearms, watches, sewing machines, art objects etc., often register serial numbers on their products as a means of identification or to establish ownership. Individuals in possession of expensive silver or stainless steel wares frequently get their names inscribed on these articles for identification. When criminals steal such property they may attempt to alter or erase the identification marks by either filing the surface bearing marks with file or by using sand paper or grinding wheel. It is almost impossible to alter such marks without leaving obvious evidence of an attempted erasure. Forensic laboratory is increasingly called upon to restore such erased numbers or names to enable the police to identify the stolen property with the owner. Restoration of obliterated marks is often possible in the laboratory, partly or wholly.

5.4.1 Types of Marks

Three types of marks are commonly found on the articles:

1) *Cast marks:-* These types of marks are raised above the surface of the metal, but sometimes cast marks may sink into the metal surface. Such marks form part of the mould and appear on the metal surface when it is cast. Cast marked numbers or names do not generally identify the main product. It may only identify a component of the product. If the cast marks are erased, it is not possible to restore them and is not of much help either.
2) *Engraved marks:-* Two types of engraved marks are common, marks engraved by using chisel, and those made with an electric engraver. If marks made by chisel or electric engravers are obliterated, it can be restored provided the erasure is not too deep. But the success of restoring engraved numbers is much less than in the case of punched numbers or marks. This is because the engraved marks are made with much less pressure leaving very little alteration of crystal structure of the metal.
3) *Punched marks:-* Majority of articles bear serial numbers, which are obtained by striking the metal surface with a die bearing the marks in relief. The die is forcibly hammered into the metal, which results in compression of the metal causing

disturbance of the surface underlying it. Erased punched marks of these types can often be restored, as in the case of engraved marks, provided the filing has not been very deep.

5.4.2 Principle of Restoration

Serial numbers are usually stamped on a metal body or frame or on a plate, with hard steel dies. These dies strike the metal surface with a force. This results in the crystalline microstructure of the metal to get compressed and strained. The strained surface extends a short distance beneath the indented number. When a suitable chemical reagent is applied, the strained and unstrained areas will dissolve the metal at different rate. The unequal rate of dissolution, of strained and unstrained metal, permits bringing out the original numbers. But if the erasure is deep and has reached the zone of strain, then it is usually not possible to restore the number of marks.

5.4.3 Technique of Restoration

The technique of applying the reagent is the same for almost all metals, but chemical formulate differ from metal to metal. In every case before treatment with chemical reagent, the obliterated surface must be thoroughly cleaned of dirt and greasy matter or paint with suitable solvent and photographed. The surface is then carefully polished with a grinding or polishing machine until the surface is quite smooth. The surface is then heated until it is just to touch, and then allowed to cool. The reagent is then applied on this surface with a cotton ball, attached to a stick or glass rod. The number is read under suitably adjusted illumination. The application and examination process is repeated until the number comes up. The number or mark may appear completely or in parts. As soon as number appears a photograph need to be taken, because it may disappear after subsequent application of the reagent. Best photograph may be obtained after application of transparent oil to the metal surface.

5.4.4 Etching Reagents Used

The choice of etching reagent will depend on the type of metal surface being worked on. The following reagents have been known to give good results:

1. *Cast iron and cast steel:-* A 10% solution of sulphuric acid plus potassium dichromate is used repeatedly on the surface.
2. *Stainless Steel:-* 10% solution of hydrochloric acid, in alcohol, can be used to restore erased numbers.
3. *Wrought, drawn and forged erased iron & steel* – Two reagents are used:

Reagent (i) -Con. hydrochloric acid 80 ml, Water 60 ml. Cupric chloride 12.9 gms, Alcohol 50 ml.

Reagent (ii) -15 Percent nitric acid

The method is to soak a cotton roll with the reagent (i) and continues to apply on the metal surface for a minute. Then apply reagent (ii) after wiping the surface for the same period. The cycle is continued until the number is developed.

4. *Aluminum:* - (i) Villela's reagent is the best known reagent which consist of:

Glycerine 30 ml, Hydrofloric Acid 20 ml. Nitric Acid 10 ml.

(ii) 10 percent sodium hydroxide solution is also found to give good results.

5. *Copper, Brass & Other Copper Alloys:-* These metals generally respond to the reagent made of:

Ferric Chloride 19 gms, Hydrochloric Acid 6 ml., Water 100ml.

5.5 TOOL MARKS

A criminal often makes use of varieties of tools in the commission of crime. Among then knives and screw-drivers are most common because of their general utility, availability and ease of concealment. Bits jimmies, saws, pliers, cutters, hammers, scissors, drills and tools specially designed for burglary like Sendh Katti are also frequently encountered in criminal investigation work.

A tool is made of a hard metal to enable it to operate effectively on softer material. It thus leaves marks on the surface, on which it operates, without damaging the tool. If the tool is not extensively used or misused, and is properly maintained, the marks are reproducible almost indefinitely. Thus, a criminal can be linked to a crime even after a long interval through the tool and tool marks.

A culprit usually uses the same set of tools in the commission of the similar type of crimes. If tool marks from various crimes are compared and found identical, the crimes can be linked. Tool marks are, therefore, of great importance in criminal investigation.

5.5.1 Nature of Marks

All tool marks can be grouped into two mains types, namely compression marks, and sliding or scrape marks. Sometimes, combination of these two types may also occur, i.e., a hammer blow may leave a compression mark, and at the same time may slide on its edges leaving a sliding mark. Another type of tool mark, sometimes encountered, is the repetitive cut mark, as often caused by saw, drill or files.

1. *Compression Marks:-* These are the marks made by forcing a tool into a material in such a manner as to leave a negative impression of the tool. The clarity and individuality of the marks depend upon the surface of the tool, the force of impact and the nature of the surface receiving the marks. The common examples of the tools making such marks are hammers, punches, dies, metallic seals and stones. Sometimes, knives, jimmies, crowbars, screwdrivers and axe may also leave compression marks.
2. *Sliding Marks:-* These are caused by the sliding contact of the tool with the recipient surface. The surface is scratched in a characteristic fashion depending upon the irregularities of the scratching surface of the tool. The marks are left in the form of striations. The width, depth and inter-distance vary to a certain extent depending upon the angle of application, the force used and the relative hardness of the surface. All tools cause such marks that leave compression marks, provided there is sliding motion. The tools like swords, knives, axes, scissors, chisels, can-openers, screwdrivers, crowbars, pliers, wrenches, spanners, etc., can create sliding marks.

3. Repetitive Cut Marks:- These are the marks let by the tool by its repeated operation on the recipient surface. Saw, hacksaw, file, drill etc., are the examples of this class. They do not permit identification of the tool except in rare cases when the cut mark or the hole mark is incomplete. On examining the repetitive marks it may indicate the type of tool used.

5.5.2 Location of Tool Marks

The nature of tool marks depends upon the nature of crime. If trees have been felled and stolen, axe marks may be found on stumps of the trees. If a houses has been broken open, the tool marks will be found at the point of entry, on the locks, safe doors or the almmirahs.

If telephone, telegraphic, electric or traction wires are stolen, the details of the cutting instruments will be found on the cut ends at the scene and on the stolen property.

The stolen parts of vehicles like hub-caps, head-light covers etc., will carry impressions of nails or bolts.

Any object coming in contact with a tool will be able to carry marks of that tool.

5.5.3 Collection of Evidence Bearing Tool Marks

The original articles bearing the questioned tool marks should be collected. If it is not possible, then casts of tool marks in sulphur, plasticine, dental cement etc., should be obtained. While collecting the tool it is important to preserve the traces on it such as paint, oil, metallic residue etc. These traces are as valuable as the tool and tool marks.

If pieces of wire that have been cut are to be sent for examination, the suspect end of the wire should be clearly marked. The suspect tool must not be used to cut these wire ends.

5.5.4 Principle of Comparison of Tool Marks

Practically, it is impossible to manufacture two tools which are exactly alike. Most of the tools used in crime are not manufactured under controlled conditions. They therefore, frequently show gross differences in addition to microscopic variations. Their repeated use result in wears, dents etc. reshaping of tools will introduce additional features or alter original features, which make the tools distinguishable from one another.

5.5.5 Preparation of Test Marks

It is very difficult to reproduce test marks of the tool even if they are made of similar materials, in a similar manner and with corresponding position and portion of the tool. It is, therefore, essential to pay utmost care and attention while making proper standards. The test marks are made on a soft material so that the tool edge does not get altered. When the original mark is in wood, paint or soft metal, the standard should be made with the same material. When the original mark is on a hard metal, such as steel, it is not desirable to use same material as standard. In such cases lead or tin sheet may be used for test marks.

5.5.6 Comparison of Marks

The standard and questioned marks are compared usually under the comparison microscope. Due to wide variation in tool marks, the presence of a clean-cut made of a reasonable portion of the questioned and the standard marks can be virtual proof that the same tool made both marks. The marks, under identical conditions of lighting and positioning, look like a series of parallel lines of variable width and arrangement. If both marks resemble to a considerable degree, then they are said to be identical.

5.5.7 Guidelines and Precautions

1. The tool marks should be protected with cotton.
2. In case of theft of electric wires etc., the crime cut end to be examined should be marked properly and the other end cut by the investigating officer should be bent so as to distinguish from crime end.
3. The crime tools recovered should not be put to use before forwarding to FSL.

5.6 SPURIOUS ARTICLES

5.6.1 Introduction

Imitation and duplication of wide range of articles have become a lucrative business in almost all commodities from household articles to the huge machinery & equipment. Quite often, such instances are brought to the notice of investigating agencies, which come under the category of cheating, fraud, infringement of trademark Act, Copy Right Act and the most recent Intellectual Property Rights Act.

During the past decade articles such as soaps, talcum powder, detergents, beedies, weights & measures, automobile spare parts etc., are also being made fraudulently and marketed. Manufactures of fake items invariably select a popular brand article and attempt to copy it. It is always possible to trace the origin and source of manufacture and to compare it with the specifications of standard items both in terms of the printed matter on the labels quality of the material used for labels and wrappers etc. Usually the nature and quality of the contents will be highly inferior and very much below standard specifications. When the original and spurious articles are subjected to microscopic and other physico-chemical studies, it is possible to determine these differences in quality and even to trace the source of manufacture. In all these cases extensive standard / control (genuine) samples of the same size, batch, manufacturing date as that of the suspected article are required to be procured from the authorized dealer / manufacturer along with certificate for comparison, in addition to the complete history and background of the people behind operation, place of manufacture, source of raw materials etc., in order to make thorough and systematic examination.

5.6.2 Nature of physical evidence received by the section, nature of examinations conducted and type of analytical information laboratory can provide is given below:

Sl.	Nature of Physical Evidence	Nature of examination conducted	Type of analytical information laboratory can provide
1.	Spurious articles: (in the form of labels, trade marks, brand name, logo, specifications etc., found on the covers, packages) cement, Soap, Washing / talcum powder, Pain balms, Oils, Fans, Tobacco products such as gutka, pan masala, jarda, Sewing machines, Automobile spare parts, Seals, Printed matter, Court fee stamps, Cloth / fabrics, Machine parts etc.	*1.* Physical parameters such as length, size, shape, pattern, design, weight, volume, density etc. 2. Microscopic examination. 3. Fluorescence under UV Light.	Whether the labels, trade marks, brand names, logo etc., found on the covers / packages and the product of the spurious tallies with the standard or not.

5.7 COUNTERFEIT CURRENCY

5.7.1 Introduction

Counterfeiting of currency is as old as genuine. It is said that „Counterfeiting is an offence never committed by accident, or by ignorance, or in the heat of passion, nor in extremity of poverty. It is a crime expertly designed by one possessing technical skill and lays out substantial sums for equipment. Improved methods of photography and printing processes, advent of computer technology have made it easier and quicker for counterfeiting.

5.7.2 Production of Government Currency Notes

The Government currency notes are printed at Currency Note Press at Nasik (by wet offset printing process) and Bank Note Press at Dewas, Madhya Pradesh (by intaglio printing process). In the Intaglio printing process the inked areas are raised above the surface of the paper and can be felt by hand. New currency note printing presses have also come up at Mysore and Kolkatta.

The paper used for printing notes is special type containing water marks and security thread and is manufactured at Security Paper Mill in Hoshangabad in Madhya Pradesh.

5.7.3 Special Features

The Mahatma Gandhi series-1996 banknotes contain the following special features

i) *Security thread:* Rs.10, Rs.20 and Rs.50 notes contain fully embedded security thread. Rs.100, Rs.500 and Rs.1000 banknotes contain windowed security thread. This thread is partially exposed and partially embedded. When held against light, this thread can be seen as one continuous line. Other than on Rs.1000 banknotes, this thread contains the words 'Bharat' in the Devanagari script and 'RBI' appearing alternately. The security thread of the Rs.1000 banknote contains the inscription 'Bharat' in the Devanagari script, '1000' and 'RBI'.

ii) *Latent Image:* The vertical band next to the (right side) Mahatma Gandhi's portrait, contains a latent image, showing the denominational value 20, 50, 100, 500 or 1000 as the case may be. The value can be seen only when the banknote is held horizontally and light allowed to fall on it at 45 ; otherwise this feature appears only as a vertical band.

iii) *Micro letterings:* This feature appears between the vertical band and Mahatma Gandhi portrait. It contains the word ÂRBIÊ in Rs.10. Notes of Rs.20 and above also contain the denominational value of the banknotes. This feature can be seen better under a magnifying glass.

iv) *Identification mark:* A special intaglio feature (raised printing) has been introduced on the left of the watermark window, on the obverse (front) on all banknotes except Rs.10/- banknote. This feature is in different shapes for various denominations (Rs.20-Vertical Rectangle, Rs.50-Square, Rs.100-Triangle, Rs.500-Circle, Rs.1000-Diamond) and helps the visually impaired to identify the denomination

v) *Intaglio Printing:* The portrait of Mahatma Gandhi, Reserve Bank seal, Guarantee and promise clause, Ashoka Pillar Emblem and RBI Governor's signature are printed in intaglio i.e. in raised prints in Rs.20, Rs.50, Rs.100, Rs.500 and Rs.1000 banknotes.

vi) *Fluorescence:* The number panels of the banknotes are printed in fluorescent ink. The banknotes also have optical fibres. Both can be seen when the banknotes are exposed to ultra-violet lamp.

vii) *Optically Variable Ink*: The numeral 500 & 1000 on the Rs.500 [revised colour scheme of mild yellow, mauve and brown] and Rs.1000 banknotes are printed in Optically Variable Ink viz., a colour-shifting ink. The colour of these numerals appears green when the banknotes are held flat but would change to blue when the banknotes are held at an angle.

viii) *Watermark:* The banknotes contain the Mahatma Gandhi watermark with a light and shade effect and multi-directional lines in the watermark window.

MG series – 2005 banknotes:

MG series 2005 banknotes are issued in the denomination of Rs.10, Rs.20, Rs.50, Rs.100, Rs.500 and Rs.1000 contain some additional / new security features. The Rs.50 and Rs.100 banknotes were issued in August 2005, followed by Rs.500 and Rs.1000 denominations in October 2005 and Rs.10 and Rs.20 in April 2006 and August 2006, respectively.

The additional / new security features in MG Series 2005 banknotes.

i) *Security Thread:* The machine-readable security thread in Rs.10, Rs.20 and Rs.50 denomination banknotes is windowed on front side and fully embedded on reverse side. The thread fluoresces in yellow on both sides under ultraviolet light. The thread appears as a continuous line from behind when held up against light.

ii) Rs.100, Rs.500 and Rs.1000 denomination banknotes have machine-readable windowed security thread with colour shift from green to blue when viewed from different angles. It fluoresces in yellow on the reverse and the text will fluoresce on the obverse under ultraviolet light.

iii) *Intaglio Printing:* The portrait of Mahatma Gandhi, Reserve Bank seal, Guarantee and promise clause, Ashoka Pillar emblem, Governor's signature and the identification mark for the visually impaired persons are printed in improved intaglio.

iv) *See through register:* Half the numeral of each denomination (10, 20, 50, 100, 500 and 1000) is printed on the obverse (front) and half on the reverse. The accurate back to back registration makes the numeral appear as one when viewed against light.

v) *Water Mark and electrotype watermark*: The portrait of Mahatma Gandhi, the multi- directional lines and an electrotype mark showing the denominational numeral 10, 20, 50, 100, 500 and 1000 appear in this section respectively in each denomination banknote and these can be viewed better when the banknote is held against light.

vi) *Optically Variable Ink (OVI):* The font size of the numeral 500 and 1000 in Rs.500 and Rs.1000 denomination banknotes is reduced, as compared to MG series banknotes issued in these denominations earlier in the year 2000. The colour of the numeral appears green when the banknote is held flat but would change to blue when the banknote is held at an angle.

vii) Dual coloured optical fibres, seen under UV lamp.

viii) Year of Printing: Year of printing appears on the reverse of the banknote

Why was the change brought about?

Central banks, the world over change the design of their banknotes and introduce new security features primarily to make counterfeiting difficult and to stay ahead of counterfeiters. India also follows the same policy.

5.7.4 General differences between Genuine and counterfeit notes:

S. No	Feature	Genuine notes	Counterfeit notes
1	Paper	The paper of genuine Bank Notes is made from 100% cotton pulp and can be identified by the perception of touch & its distinct crackle.	As the paper used is ordinary commercial paper, the crackle is generally absent.
2	Watermark	Three watermarks viz., portrait of Mahatma Gandhi, RBI, the denomination of the note are created.	This watermark is prepared by the use of hot moulded cylinder with hot wax or white paint which can be identified under transmitted / UV Light.
3	Optical fibres	Three yellow, blue & green optical fibres are introduced which can be seen under the UV Light.	There may be fibres of single colour or absent.

4	Security thread	i) It is a metal coated synthetic filament introduced in the paper during pulpy state. There is micro printing on the security thread & under the transmitted light the words RBI & Bharat alternately can be read through out the length of the thread. ii) Security thread can be seen as regular and bold line under transmitted light. iii) Security thread gives deep blue fluorescence under UV. iv) Shining segments are six in number.	i) Micro printing is generally absent. ii) This line is broken or segmented. iii) Violet or no fluorescence. iv) May be more than six.
5	Intaglio Printing	On the obverse side the signature of Governor, promissory note, Mahatma Gandhi Emblem, Braille Mark are printed by intaglio process with raised printing. This can be felt by rubbing with finger.	As they are generally printed with Dry or Wet Offset Printing this feature is absent.
6	UV Fluorescence	The paper of genuine note does not give any florescence.	The paper may give florescence.
7	Braille/identification Mark	A special design is created on the left side of the watermark window which can be identified by finger touch.	This feature may be printed and may not be identified by finger touch.

8	See-through register	A floral design is created on the both front and back side which are in perfect alignment.	Theremay not be perfect alignment.
9	Micro Printing	This has been created at the back side of the head and ear of Mahatma Gandhi. This area is filled with letters RBI & denomination.	Micro lettering is absent or defective with broken edges.
10	Latent Image	On the right side hidden under the green coloured vertical band latent image of the denomination has been created using special technology.	Latent Image is absent.
11	OVI Feature	The denomination of the note is printed at the middle of the note with shining green OVI (Optically Variable Ink). The figure change the colour from green to dark blue when the note is tilted.	This feature is absent.
12	Font Size	A careful examination and comparison of the numbers and series show difference in font size.	Font size is normally smaller.
13	Printing Processes	Offset / intaglio printing processes.	i) If prepared by scanning and printing under ink- jet printer shows many defects such as multi coloured dots on both sides. No security thread observed. ii) If prepared by multi coloured Xerox Copying show sheen (Shining) of printing on both sides of the note due to thermal effect. These lack other security features.

5.7.5 Search for Evidence

- Printing blocks, which may be of Zinc or Copper, may be mounted or unmounted on the press.
- Etched or hand engraved blocks or plates.
- Photographic negatives or positives.
- Photographic films or chemicals for developing or etching.
- Block or die for watermark.
- Printing inks.
- Cutting devices.
- Wax, oil, brushes, gum etc.
- Small printing machines.
- Hand numbering machines or typesetting machine.
- Colour photo coping machines.
- PCs and scanners.

GLOSSARY

1. Soil
2. Paint
3. Tool Marks
4. Glass

LEARNING OUTCOME

After studying this unit you should be able to:

1. Mention the different properties of Glass.
2. Evaluate Glass fractures.
3. Mention various Collection and Preservation methods for Paint.
4. Various Guidelines and precautions in collection of different samples.
5. Elaborate Nature of Marks.

SUGGESTED READINGS

1. Solving Crimes with Physics- Mr. William Hunter.
2. Forensic Science- An Introduction- Mr. Richard Saferstein.
3. Forensic Evidence- Science and the Law- Mr. Terrence F Kiely.