HANDOUT 3: Forensic Science

Forensic science can be simply defined as the application of science to the law. In criminal cases forensic scientists are often involved in the search for and examination of physical traces which might be useful for establishing or excluding an association between someone suspected of committing a crime and the scene of the crime or victim.

Such traces commonly include blood and other body fluids, hairs, textile fibres from clothing, materials used in buildings such as paint and glass, footwear, tool and tire marks, flammable substances used to start fires and so on. Sometimes the scientist will visit the scene itself to advise about the likely sequence of events, identify any indicators as to who the perpetrator might be, and join in the initial search for evidence.

Other forensic scientists analyze suspected drugs of abuse including specimens from people who have taken drugs or who have been drinking and driving, or who may have been poisoned. Yet others specialize in firearms, explosives, or documents whose authenticity is questioned.

Forensics in Court

Forensic scientists can appear for either side - prosecution or defence in criminal matters, and plaintiff or defendant in civil ones. They tend to present their findings and opinions in written form either as formal statements of evidence or reports. Sometimes they are required to attend court to give their evidence in person.

As an integral part of the RCMP National Police Services, the Forensic Laboratory Services (FLS) is responsible for conducting analyses and examinations of physical evidence and in reporting results and conclusions in connection with police investigations anywhere in Canada. Its services are primarily available to police agencies, courts and government agencies in most provinces (Ontario and Quebec have their own provincial forensic laboratories).

Based on the results of their work, members of the Forensic Laboratory Services issue case reports and provide expert forensic testimony to the courts. In certain cases, the laboratory staff can — on request — provide advice and opinion to interpret evidence in situations where a hypothetical scenario may have been established, but where laboratory examinations have not been requested.

New and advanced forensic methods are developed through research. Working as a team, Forensic Laboratory Services aims to provide state-of-the-art service and forensic science capabilities in a diverse range of scientific disciplines. Laboratory sites are located in Vancouver, Edmonton, Regina, Winnipeg, Ottawa, and Halifax. The National DNA Data Bank is located in Ottawa.

Some areas of Forensics include:

- Forensic Biology
- Forensic Pathology
- Forensic Entomology
- Forensic Chemistry/Toxicology
- Forensic Counterfeits and Documents
- Forensic Firearms Identification or (Ballistics)

Forensic Biology

What does a Forensic Biologist do?

A forensic biologist is a person with a biology degree who works in a lab and processes specimens that are brought to him or her by the police. It is the biologist who performs serological and DNA analyses of physiological fluids for the purpose of identification and individualization. The type of material typically examined includes, but is not limited to, blood and semen, collected at crime scenes and from articles of physical evidence. These types of physiological fluids are frequently generated during the commission of violent crimes such as homicides, rapes, assaults, and hit and run fatalities. In some cases, the biologist may have to testify in court as an expert witness.

DNA evidence

A new form of identification relies on DNA, which carries the genetic information of each person. Everyone's DNA is different (except for identical twins). DNA profiling or typing is sometimes called DNA fingerprinting because it allows police to identify an individual in the same way as fingerprints do. DNA can be extracted from any body fluid (blood, saliva, sweat, or nasal mucus) or from fragments of a body (hair roots, torn skin or flesh).

Forensic scientists do not look at the whole of a person's DNA sequence, but rather a sub-set of a DNA profile. DNA profiles are a very powerful means of determining whether two or more samples may or may not have come from the same person. If DNA profiles do not match, they came from different people. However, if they do match, there is still a very slight chance that they may have come from different people.

DNA is the same in every cell of the body, and stays the same throughout life. As such, DNA profiles taken at different times and places can be compared in order to determine whether or not they come from the same person.

DNA analysis does not enable scientists to build up a picture of a person from their DNA. The only characteristic that the DNA tells us is the sex of the person. DNA profiling is only used to compare different DNA samples, and to determine whether or not they could be from the same person. Biological trace evidence is processed using DNA analysis techniques to generate DNA typing profiles. RCMP services include:

- Comparing DNA profiles to determine if there are any forensically significant associations
- Submitting selected DNA typing profiles for entry into the Crime Scene Index of the National DNA Data Bank of Canada.

Fingerprinting

Analysis of fingerprints is probably the most well known use of forensic science. Each fingertip has a pattern of fine skin ridges that are slightly different for every person - even identical twins.

A fingerprint is composed of grease and dried sweat left behind by the tips of the fingers. The palms of the hand also leave identifiable prints, as do the soles of the feet. Often the forensic biologist would examine this evidence.

Fingerprints can be detected on a vast range of different surfaces using a variety of techniques. The police keep a huge national database of prints taken from charged criminals. New prints are taken by a laser-scanning procedure, where the hand is placed on a flat glass plate, and its print is stored and compared to other prints electronically.

Forensic Pathology

Forensic Pathology is the legal branch of pathology concerned with:

- Determining cause of death (including murder, accident or unexpected death)
- Examination of some wounds and injuries due to crime or negligence
- Examination of tissue specimens that may be relevant to rape, or other crimes

The examination of dead bodies (autopsy) is closely related to anatomical pathology. A forensic pathologist is a medical doctor who has specialized in the field of Pathology with several years of advanced training. In Canada, Forensic Pathology is not a separate specialty from Pathology. Therefore, doctors specialize in Pathology and often go to the United States for experience in Forensic pathology. In the U.S., a separate specialty in forensic pathology exists. The forensic pathologist autopsies bodies and determines the cause of death and all other factors that relate to the body directly. They may attend crime scenes and frequently testify in court.

Forensic pathologists work closely with the Coroner (British tradition) or Medical Examiner (American tradition). In some Provinces, there is a Medical Examiner system and in other provinces there is a Coroner's system. Medical Examiners must be medical doctors, but not necessarily forensic pathologists. Only the Chief and Deputy Medical Examiner are usually Forensic Pathologists. In Ontario, Coroners are also doctors, but in the rest of Canada, coroners are lay coroners and come from many backgrounds. In most cases, the position is part-time, fee-for-service.

Not all bodies that end up on an autopsy table are necessarily of forensic interest. It is the job of the forensic pathologist to determine the cause and manner of death. If the manner of death is 'accidental' then the case is not a forensic case.

Forensic Entomology

Forensic Entomology is the use of the insects, and their arthropod relatives that inhabit decomposing remains to aid legal investigations. The broad field of forensic entomology is commonly broken down into three general areas: medico legal, urban, and stored product pests.

- The medico legal section focuses on the criminal component of the legal system and deals with the necrophagous (or carrion) feeding insects that typically infest human remains
- The urban aspect deals with the insects that affect man and his immediate environment. This area has both criminal and civil components as urban pests may feed on both the living and the dead. The damage caused by their mandibles (or mouthparts) as they feed can produce markings and wounds on the skin that may be misinterpreted as prior abuse. Urban pests are of great economic importance and the forensic entomologist may become involved in civil proceedings over monetary damages.
- Lastly, stored product insects are commonly found in foodstuffs and the forensic entomologist may serve as an expert witness during both criminal and civil proceedings involving food contamination

Forensic Chemistry/Toxicology

Forensic chemists deal with non-biological substances, such as paint, potential fire accelerants, glass, fibres and textiles, plastics, building products, safe insulation and commercial products. A forensic chemist frequently conducts physical matching of seized materials and makes use of resources such as “The Paint Data Query” (PDQ) database, a searchable database of chemical and colour information of original automotive paints.

Forensic toxicologists deal mainly with body fluids to determine, for example, the level of alcohol or drugs a person has consumed and how these toxins would affect the person.

A wide array of laboratory techniques and instrumentation is used in forensic chemistry and toxicology studies. This includes ultraviolet, infrared, and visible spectrophotometry; neutron activation analysis; gas chromatography and mass spectrophotometry; high pressure liquid chromatography; and atomic absorption spectrophotometry. The techniques and instrumentation chosen depend on the type of sample to be examined.

The fact that most samples examined are not pure substances, but are often mixed with dirt or debris, presents a major challenge to the forensic chemist. This may also be an advantage, as every substance collected at a crime scene is a unique mixture of chemical compounds that can ultimately be identified. Arsonists, for example, often use accelerants such as gasoline or kerosene to speed combustion and spread flames in the interior of a building. A forensic chemist may collect samples of burned and unburned materials, extract the volatile hydrocarbons, and separate the components for analysis by gas chromatography.

Forensic Counterfeits and Documents

Counterfeiting is a crime as old as currency itself. Just about any document can be counterfeited. Aside from currency, this can include forged credit cards, debit cards, passports, birth certificates, social insurance number cards, traveller's cheques, marriage and driver's licences, bus and airline tickets, and money orders. Historically, counterfeiting of currency has not been a major problem for law enforcement in Canada. However, developments in the field of graphic arts attracted the attention of the criminal element in the early 1960s.

As a result, counterfeit currency rates increased substantially in 1962 and this trend has continued ever since. Although statistics for the last two years show that counterfeiting rates are dropping, easier access to affordable, improved personal computer and image reproduction technology has dramatically changed the nature of counterfeiting. It is an international problem.

RCMP Procedures

Counterfeits

The counterfeits component examines suspect travel documents including passports and visas, as well as currency and credit cards, to determine if they are genuine. It also:

- Conducts forensic examinations of Canadian and foreign banknotes and coins
- Classifies and records information pertaining to banknotes and counterfeit travel documents and disseminates this information to Canadian law enforcement and to foreign partner agencies on a bilateral basis.

Documents

The documents section examines questioned documents to identify author, method of production, and if they have been altered. It also:

- Conducts handwriting and hand printing comparisons
- Establishes the means, media and materials used to produce documents (e.g. typewriters, computer printers, photocopiers, facsimiles, cheque writers, rubber stamps, and other graphic art media)

- Determines alterations, additions or deletions of documents
- Restores documents damaged by fire, water or other substances
- Detects and deciphers latent or partially hidden indentations

Forensic Firearms Identification or (Ballistics)

Sometimes incorrectly referred to as ballistics, firearms identification can be defined as: The identification of fired bullets, cartridge cases or other ammunition components as having been fired from a specific firearm.

Firearms identification is actually a form of Toolmark Identification where the firearm, because it is made of a material harder than the ammunition components, acts as a tool to leave impressed or striated marks on the various ammunition components that come into contact with the firearm.

Firearms evidence submitted to a lab's Firearms Section will typically include:

- A firearm
- Fired bullets
- Spent cartridge cases
- Spent shot shells
- Shot
- Shot shell wadding
- Live ammunition
- Clothing
- Other related item

In addition to comparing ammunition components to firearms, firearm examiners conduct other examinations that usually include the following:

- Testing firearms to determine if they function properly
- Examining clothing and other items for gunshot residues and/or shot patterns in an attempt to determine a muzzle-to-garment distance
- Determining caliber and manufacturer of ammunition components. Including the examination of various shot shell components
- Determining the manufacturer or manufacturers of firearms that may have fired a particular bullet or cartridge case

Firearm examiners will perform specific scientific examinations upon the evidence submitted. Once the examinations are completed reports detailing their findings are

forwarded to the investigating officer and eventually to all parties involved in any subsequent criminal proceedings.

Firearm examiners finish their involvement in a case by presenting their findings in court. Analysis and Indicators Studies have shown that no two firearms, even those of the same make and model, will produce the same unique marks on fired bullets and cartridge cases.

Manufacturing processes, use, and abuse leave surface characteristics within the firearm that cannot be exactly reproduced in other firearms.

Firearms do not normally change much over time. This allows for firearms recovered months or even years after a shooting to be identified as having fired a specific bullet or cartridge case. Tests have been conducted that found that even after firing several hundred rounds through a firearm the last bullet fired could still be identified to the first. It should be noted that not all firearms leave consistent reproducible marks. But approximately eighty percent of the firearms that are examined produce what is sometimes called a "mechanical fingerprint" on the bullets and cartridge cases that pass through them.

Bullets collected for comparison to a specific firearm are examined first to see if they are of a caliber 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.