With the popularity of television shows involving crime scene investigation and evidence analysis such as “CSI,” “Law & Order,” and “NCIS,” the general public has come to expect that every case is immediately worked utilizing technology that instantaneously provides positive results that catch the “bad guy.”

Forensic scientists, however, know this is not the reality they face each day. Many of the technologies on these television programs do not function as they are depicted or do not even exist. The reality is that crime laboratories across the country deal with budget constraints, backlogs, long hours, and personnel shortages. Each of these factors can affect the turnaround time for case completion.

The Texas Department of Public Safety (DPS) began offering scientific analysis of criminal evidence in its first crime laboratory in 1937. Today, the service is provided in new headquarters — the Crime Laboratory in Austin — as well as in 12 regional crime laboratories located throughout the state. The 13 crime labs, along with the Breath Alcohol Testing Laboratories, make up the DPS Crime Laboratory Service, which is part of the Law Enforcement Support Division.

The crime lab adheres to strict guidelines and policies with regard to forensic science, from the training of its analysts to the analyses performed and results generated. This adherence has earned the crime lab accreditation with the American Society of Crime Laboratory Directors — Lab Accreditation Board (ASCLD-LAB) at the international level, which includes standards set by the International Organization for Standards (ISO). The guidelines and policies include, but are not limited to, annual proficiency testing of all forensic scientists, quality assurance procedures, internal and external audits, and rigorous, discipline-specific training programs and procedures. The goal of the laboratory is to provide quality analyses and results to various agencies at local, state, and federal levels. The goal of the forensic scientist is to evaluate all evidence in an unbiased and impartial manner.

In the state’s crime labs, forensic testing is separated into a number of disciplines: forensic DNA analysis; CODIS; trace evidence analysis; latent prints (fingerprints); Automated Fingerprint Identification System (AFIS); controlled substances and dangerous drugs; toxicology; firearms and toolmark identification; questioned documents; and digital and multimedia evidence.
A forensic scientist examines a bloodstained shirt in Richmond, Va. AP Photo/Steve Helber
Examiners with the DPS Forensic DNA Analysis Section provide the three most common types of DNA analyses: short tandem repeat (STR) DNA (commonly used to exclude or include victims or suspects), Y-Chromosome analysis (Y-STR) (most commonly used in sexual assault cases), and mitochondrial DNA analysis (mtDNA) (commonly used to identify remains).

**Forensic DNA Analysis**

Steps in DNA analysis include stain identification, DNA extraction, DNA quantitation, DNA amplification, and, subsequently, DNA profile determination. The DNA amplification process is termed “PCR” (polymerase chain reaction). This is a process where a target region of DNA is replicated over and over so that a previously insufficient amount of DNA becomes a sufficient amount of DNA for testing purposes. Numerous quality control samples and procedures are included in the process to ensure a quality result and to minimize any contamination. A laboratory report is issued, explaining results of analysis and relevant conclusions.

Interpretations for specific DNA profiles will fall into three main categories: 1) exclusions, 2) inclusions, or 3) inconclusive. For a DNA report, the laboratory will summarize the results of comparisons of DNA profiles, which may include the significance of associations with known individuals based on reference sample comparisons. Additionally, a DNA profile may be entered into the Combined DNA Index System (CODIS), a computer database that contains DNA profiles from felony offenders, arrestees, detainees, and forensic case samples. Eligible profiles can be searched against other profiles for the purpose of generating investigative leads.

Three of the most common forensic DNA analyses include short tandem repeat (STR) DNA, Y-Chromosome analysis (Y-STR), and mitochondrial DNA analysis. (The last two are used less frequently and for very specific purposes.) STR DNA analysis is the current technology performed in forensic DNA crime labs because of its high power of discrimination. STR DNA enables scientists to include or exclude victims, suspects, defendants, or convicted offenders in criminal cases using reference samples. Other than the gender of the individual, no other information about a person, such as outward appearance or predisposition to disease, is obtained from a STR DNA profile.

Y-Chromosome DNA analysis (Y-STR testing) is male-specific DNA testing. Because of lineage inheritance, Y-STR analysis is not specific enough for identification; Y-STR conclusions can be extended to any paternally related males. Y-STR testing is most commonly used in sexual assault cases when a suspect has already been identified.

Mitochondrial DNA analysis (mtDNA), which has a low power of discrimination and is found in both males and females, helps establish female lineage inheritance. Mitochondrial DNA analysis is most useful for severely degraded DNA samples most commonly found in unidentified human remains.

**CODIS**

The Combined DNA Index System, or CODIS, combines computer and DNA technologies into a tool for fighting violent crime. CODIS is the FBI’s program of support for criminal justice DNA databases, as well as the software used to run these databases. CODIS has three levels — local, state, and national — that contain DNA profiles contributed by federal, state, and local participating forensic laboratories. DNA profiles in the database originate from a number of categories, such as convicted offenders, crime scene evidence, and missing persons.

CODIS is designed to compare a target DNA record against the DNA records contained in the database. When a match is identified by the CODIS software, the laboratories involved in the match exchange information.

Pursuant to the DNA Identification Act of 1994, DNA data is confidential. Access to CODIS is restricted to criminal justice agencies and law enforcement forensic DNA crime labs for law enforcement identification purposes. Defendants are also permitted access to the samples and analyses performed in connection with their case. If all personally identifiable information is removed, DNA profile information may be accessed by criminal justice agencies for a population statistics database, for identification research and protocol development purposes, or for quality control purposes. The unauthorized disclosure of DNA data in the National DNA database is subject to a criminal penalty not to exceed $250,000.
Currently, DNA data generated through PCR STR technology, Y-STR chromosome technology, and mitochondrial DNA (mtDNA) technology are accepted into the National DNA Index System (NDIS). Y-STR and mtDNA data is only searched with missing person-related indexes.

**Trace Evidence Analysis**

During a crime, exchanges of physical evidence may occur between the victim, suspect, and the crime scene. For example, a suspect may leave a shoeprint at a crime scene or may take away fibers shed from an item of clothing worn by the victim. The DPS’ Trace Evidence laboratory specializes in the examination of this type of evidence with the goal of linking suspects to victims and/or crime scenes. The analysis of trace evidence most often begins with a visual examination of the evidence, which is then usually followed by microscopic, chemical, and instrumental analysis. The type of analysis is dependent on the type of material to be analyzed. Examples of trace evidence may include, but are not limited to, fracture (physical) match, hairs, fibers, paint, lamp filaments, impressions, glass, gunshot primer residue (GSR), and unknown substances.

Additional evidence submitted for analysis may be materials not routinely analyzed by the laboratory. The identification or characterization of these materials is accomplished by the examination of its physical and chemical properties and/or by the use of analytical instrumentation.

**Latent Prints (Finger Prints)**

A forensic scientist in the Latent Print Section is tasked with multiple duties, including processing various items of evidence submitted to the lab, where physical and chemical methods are utilized for the development of latent prints. Developed latent prints that are suitable for comparison purposes are preserved by the forensic scientist utilizing digital photography, digital scanning, or tapelifting techniques. These preserved latent prints may then be compared to known finger and/or palm prints for suspects and victims, if available. All cases without suspects are forwarded to the Latent Automated Fingerprint Identification System (AFIS) Section for further analysis. If requested by the submitting agency, cases with latent prints not identified to the listed suspect(s) may also be forwarded to the Latent AFIS Section.

In addition, lab staff attend crime scene investigations, collecting and preserving potential latent print evidence. Whether it be evidence submitted to the lab or evidence collected from a crime scene by lab staff, a report is prepared that summarizes the results of analyses performed by the forensic scientist assigned to the case. This report is provided to the submitting agency for potential investigative purposes.

**Automated Fingerprint Identification System**

Since 1991, the Latent AFIS Section has provided law enforcement agencies with latent print searches through the state’s NEC Automated Fingerprint Identification System, or AFIS, a searchable database of known fingerprints and palm prints from a variety of sources. The AFIS can help law enforcement agencies when no known suspects exist and all other leads have been exhausted. Before the implementation of the palm print system in March 2009, the lab was limited to searching only those latent prints that appeared to be finger impressions.

The AFIS also consists of an added feature known as the Unsolved Latent Database. If an AFIS search is performed and the search yields negative results, a latent print technician has the option to store the unidentified latent print in this database. As new incoming arrest and applicant cards are added to the system, the newly acquired known prints are searched against the latent prints that are housed in the Unsolved Latent Database for a possible match. There are currently approximately 126,000 unidentified latent prints stored in the database.

In addition to searching latent prints through the State system, the Latent AFIS Section also has the equipment and capability to search latent prints against the FBI’s fingerprint repository, the Integrated Automated Fingerprint Identification System. This is done through a process known as an interagency search. When a local law enforcement agency requests an interagency search, the lab receives print cards from the requesting agency and then cross-searches against the FBI’s repository to search for latent prints that may belong to suspects in the requested agency’s case.
controlled substances and dangerous drugs

The Texas Department of Public Safety provides drug analysis in all 13 of its crime labs. The forensic chemist examines drug evidence based on a written set of standard operating procedures and training. The lab's forensic chemists are charged with identifying any controlled substance or dangerous drugs that are contained in each exhibit.

Evidence to be analyzed is retrieved from a secure evidence vault by the chemist, who then completes a worksheet that reflects the testing performed and includes any notes taken and observations made. Testing includes taking the weight of each exhibit of evidence analyzed, chemical or instrumental screening, and confirmation. Work notes are reviewed by another qualified chemist to verify that the findings are valid and accurate and to establish that sufficient analysis has been performed.

After analysis, the evidence is resealed and returned to the secure evidence vault and remains stored in a sealed condition until it is returned to the submitting law enforcement agency, provided as evidence in a court trial, or destroyed.

The lab report is then issued to the submitting law enforcement investigator.

Toxicology

The function of the DPS Toxicology Section is the analysis of alcohol and drugs in body fluids for investigation of cases of driving while intoxicated (DWI), drug-facilitated sexual assault, homicide, and drug overdose. These analyses require specialized instrumentation and procedures. Forensic scientists conduct the tests, evaluate report results, perform interpretations of results, maintain quality procedures, and present these results to the courts. Toxicology, like all forensic sciences, is advancing rapidly in its ability to support investigators.

The Toxicology Section's support is primarily for law enforcement agencies initiating the investigations in a professional and unbiased manner. Scientists examine the evidence that may be used against a suspect while assuring that quality procedures are followed.

Toxicology has been impacted with the increased emphasis on quality control. Toxicological analysis is very dependent on technology. Even with the best of instruments, decisions have to be made by the analyst in application of that technology. The instruments must be maintained and performance must be verified. Lab analysts must have academic preparation for chemical analysis.

Firearms and Toolmark Identification

The forensic science of firearms identification is sometimes incorrectly referred to as “ballistics,” which is the study of a projectile in motion. 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 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 examiners 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 proceeding. Firearms examiners may finish their involvement in a case by presenting their findings in a court of law.

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

• Test firearms to determine if they function properly;
• Examine clothing and other items for gunshot residues and/or shot patterns in an attempt to determine a muzzle-to-garment distance;
• Determine caliber and manufacturer of ammunition components, including the examination of various shotshell components;
• Determine the manufacturer or manufacturers of firearms that may have fired a particular bullet or cartridge case;
• Compare impressed or striated toolmarks on various metal surfaces (such as pad locks) as having come into contact with a specific tool surface (such as bolt cutters); and

The State of Forensic Science

System (IAFIS), which currently searches the fingerprints of more than 68.7 million subjects in the National Criminal History Record File and increases daily by 8,000 to 10,000 subjects.

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Serial number restoration (after an attempt has been made to obliterate the number).

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, however, that not all firearms leave consistent reproducible marks.

**Questioned Documents**

Questioned document examination includes examining a document to address forgery detection, determining when a document was produced and what may have happened to a document, and procuring information from an altered document. Forensic document examiners also conduct laboratory examinations that include charred document restoration, latent writing impression restoration, obliteration and alteration detection, counterfeit detection, and image enhancement. Examiners also conduct handwriting examinations. Most handwriting comparison cases focus on the quality and quantity of handwriting characteristics. Unlike other types of physical evidence — which are static in nature — handwriting is dynamic, meaning that it changes over time and for a multitude of reasons, including age, injury, illness, alcohol or drug use, medication, intentional distortion, etc.

Additionally, since handwriting is variable, there is no set number of pages or volume of writing that can be known in advance that will exhibit all of the identifying or eliminating handwriting characteristics of a writer.

**Digital and Multimedia Evidence**

In today’s society, digital devices are used on a daily basis for communication, business, and entertainment. As such, digital devices have become extremely important to solving crimes. The state’s crime lab offers examination of digital devices, or digital and multimedia evidence (DME). According to the American Society of Crime Lab Directors-Lab Accreditation Board, digital media evidence is subsequently divided into three concentrations: 1) computer forensics, 2) image analysis, and 3) audio/video analysis. Image analysis and audio/video analysis deal with the technical enhancement of an image, audio, or video file as it relates to a crime, while computer forensics involves the recovery or extraction of data from digital devices.

New technology is introduced daily, and, for this reason, training is especially important to this area of forensic science. To avoid the loss of digital media evidence, caution must be exercised when collecting, transporting, examining, and storing the evidence. Forensic examiners must take care to preserve data on the media evidence. Specialized hardware and software is used for this reason. An exact copy of the data is created, called an image. All examinations and searches are performed on this copy of the original data. A unique identifier of the original data and the image is compared and referred to in order to ensure no data has been changed or lost.

When the examination is complete and data has been recovered or extracted, the information will be reported, usually in electronic format. Enough information about each file recovered is provided so it can be traced back to its exact location on that digital media if necessary. The search for that data must be repeatable so that any challenges to the existence of the information or files can be verified.

This article is excerpted from “Crime Laboratory Service 2011.” A full version of the article is available at www.texasbar.com/tbj. The following Texas Department of Public Safety Crime Laboratory Service staff contributed to this article: D. Pat Johnson, Deputy Assistant Director; Law Enforcement Support Division, Crime Laboratory Service; Cathy McCord, DNA Section Supervisor, Lubbock Crime Laboratory; Lorna Beasley, Regional Section Manager, DNA, Garland Crime Laboratory; Alice Amilhat, DNA Section Supervisor, El Paso Crime Laboratory; Jennifer Howard, Forensic Scientist II, Austin Crime Laboratory; Mark Wild, Forensic Scientist IV, Austin Crime Laboratory; Brian Strong, Forensic Scientist IV, Austin Crime Laboratory; Meghan Blackburn, Forensic Scientist III, Austin Crime Laboratory; Stephanie Meek, Forensic Scientist I, Austin Crime Laboratory; Lisa Wideman, AFIS Section Supervisor, Austin Crime Laboratory; Joel Budge, Section Manager I, Austin Crime Laboratory; Glenn Harrison, Toxicology Section Manager I, Austin Crime Laboratory; Nick Britzendine, Forensic Scientist I, Austin Crime Laboratory; Dale Stobaugh, Section Manager I, Austin Crime Laboratory; and Jennifer Land, Forensic Scientist IV, Austin Crime Laboratory.