

Cold Case Solvability and Using Science in Investigations



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FOR IMPROVING LAW ENFORCEMENT INVESTIGATIONS



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Introduction

This is the third in a four-part series on defining, implementing, and managing a cold case investigation. Building from two past articles and webinars, “What is a Cold Case and How are They Solved?” and “Forming a Cold Case Unit and Managing Unit Expectations” the following will provide information about cold case solvability and using science throughout the investigative process. Specifically, techniques and tools that officers at all levels should be aware of and apply to cold case investigations. The focus will be on the various scientific methodologies that can be applied in complex death or cold case investigations as defined in this series and the application of the solvability matrix.

For the purpose of this paper, a death investigation is considered complex when advanced investigative methods need to be utilized to identify the decedent or to learn the circumstances surrounding their death. As a reminder, all deaths are viewed as suspicious until the case facts and circumstances prove otherwise, but not all deaths require advanced methods. As an example, investigating the death of a known individual who is elderly, infirmed, and at home is less complicated than investigating the death of an unknown individual that is found decomposed in a public place. While the death of the known elderly individual should certainly be investigated critically, a thorough scene investigation, consultation with the decedent’s physician, and perhaps a postmortem examination should fairly quickly provide an opinion that the death was from natural causes. This is opposed to the second scenario that would require an anthropologist’s consultation, advanced postmortem fingerprinting techniques, an odontologist, or DNA testing, etc.

Sometimes a complex death case almost starts out as “cold,” requiring the use of many forensic methods to accomplish investigative goals. As detailed in Part 1 of this series—**“What is a Cold Case and How are They Solved?”**—using new scientific processes and techniques not available to our predecessors is a primary way cold cases are solved. This idea is usually implemented in the form of deoxyribonucleic acid (DNA) testing or retesting. While forensic DNA testing is a primary scientific method used to further unresolved cases, it is not the only method. Below is a list of scientific methods that can be used in cold cases (or complex death cases), along with tips on how they can be applied.

Investigative Science Methodologies

Tip #1: DNA labs often retain previously submitted samples that have not been consumed during the original testing. These unconsumed samples can be used for retesting even if the original item(s) of evidence is not available.

Deoxyribonucleic Acid (DNA) – Items or materials that may possess or are known to possess biological evidence should be submitted to an appropriate lab for testing. This method can also be applied for the retesting of evidence that has previously been tested but yielded negligible results, or insufficient results for comparison to a known genetic profile or entry into the Combined DNA Index System (CODIS). DNA testing has become much more sensitive over the years, so resubmitting such samples can accomplish investigative goals. This means that low quality/quantity samples and degraded samples are producing stronger profiles more now than in years past.

In regard to the architecture of the federal DNA database, also known as CODIS, please know that there are three levels. They are the Local DNA Database (LDIS), the State DNA Database (SDIS), and the National DNA Database (NDIS). Developed DNA profiles begin at the local level (laboratory), if the profiles are sufficient, they move to the state level, and if they meet further quality assurance requirements, they move to the national level. The submitting law enforcement agency may be under the impression that the developed profile is being compared to all applicable indices throughout the country, when, in actuality, the profile has not left the respective state. It is essential that the submitting law enforcement agency understand why the profile did not meet the national requirements and resolve the issue through consulting with the laboratory. Correcting the issue can aid in solving cases.

Biometrics –Fingerprint examination is not new and was available to our predecessors. Since 1999, the FBI's Integrated Automated Fingerprint Identification System (IAFIS) has provided the world's largest person-centric database. It has provided automated ten print and latent fingerprint examinations, electronic image storage, and electronic exchanges of fingerprints and responses. Advancements in technology have allowed further development of biometric identification services. Building on the foundation of the IAFIS, the Next Generation Identification (NGI) System brought the FBI's biometric identification services and criminal history information to the next level. The NGI system has improved the efficiency and accuracy of biometric services. One of the many capabilities of the NGI System is the Advanced Fingerprint Identification Technology (AFIT), which in 2011 replaced the legacy Automated Fingerprint Identification System (AFIS) and enhanced fingerprint and latent processing services. The AFIT increased the accuracy and daily fingerprint processing capacity, and improved system availability.

Tip #2: Similar to resubmitting evidence for DNA testing to take advantage of advancements in that science, an agency can resubmit known fingerprints or latent prints to learn if the upgrades in technology can further the case.

Tip #3: The FBI's NGI system offers help with palm prints, irises, and facial recognition.

Ballistics – Ballistic science is not new and was available to our predecessors, but the processing of ballistics has received important enhancements over the years. Fired cartridge casings are one piece of evidence that is found often at crime scenes, and most collected by crime scene investigators. This is especially true for outdoor scenes when the motive for the murder is robbery or drug/gang. Typically, law enforcement agencies collect these cartridge casings with the goal of matching them to the gun from which they were fired. The Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF) National

Integrated Ballistic Information Network (NIBIN) can help with this. NIBIN is a national database of digital images of spent bullets and cartridge cases that are found at crime scenes or test-fired from confiscated weapons. ATF manages the system and provides the equipment to crime labs around the country. NIBIN allows for the capture and comparison of ballistic evidence to aid in solving violent crimes involving firearms. In addition, it is possible to recover fingerprints from fired cartridge casings. This methodology is separate from NIBIN. Cold cases with cartridge casings in evidence can benefit from this science.

Forensic Anthropology-Archaeology – Obtaining the services of forensic anthropologists, physical anthropologists, and/or archaeologists are important to the investigation of complex deaths and some cold cases.

The proper excavation and removal of remains from the place of death, or from where the remains were deposited, whether legally or to conceal the crime, is imperative. Like all forensic sciences, the investigator must know what is possible as well as the limitations. Having these professionals available to assist with scattered skeletal remains cases, excavations of clandestine graves, exhumations of bodies at cemeteries, mass disasters/killings, and to review portions of cold cases is extremely helpful.

Tip #5: *Facial reconstruction or approximation is the process of recreating the face of an individual whose identity is often unknown from skeletal remains. It is a mix of art and science, a subfield of forensic anthropology. This process comes in the forms of a two-dimensional sketch and three-dimensional clay sculpture.*

While the accuracy of facial reconstruction is debated, the results do bring attention from the public to the case investigation, which is the main goal. There are concerns however, and caution should be used. Facial reconstruction is one of a few occasions where we create evidence in a case. Creating bad evidence can be fatal to the case. Make sure that the artist or sculptor providing the reconstruction has identifiable successes. Also, do not put out several different reconstructions from several different artists to the public at or near the same time. It is confusing and can cause case management problems. An individual's head hair (or lack thereof) makes a significant contribution to their appearance. While at the scene of decomposed human remains, attempt to locate the unidentified decedent's hair or hair mat, and collect it. The hair can be provided to the reconstruction team to aid in accurately depicting the individual's appearance (hair color, length, and texture).

Remote Sensing – Equipment aids in learning about an item or object without actually coming into contact with the item or object. This method is useful for finding items of evidence such as a discarded firearm or buried body. Remote sensing equipment includes ground penetrating radar, magnetometers, and thermal imaging. Thermal imaging is particularly useful for buried bodies as disturbed soil and undisturbed soil hold thermal energy differently. Utilizing the technology can help locate clandestine graves and therefore narrow areas of excavation to places that have been disturbed. Finding below-ground evidence can also be accomplished through basic archaeological methods like pedestrian survey, troweling, and probing.

Tip #4: *Know that the following can be learned through anthropological evaluation of human remains: sex, age at death, ancestry, estimated living stature, antemortem conditions/individualizing characteristics, perimortem condition/trauma analysis, and postmortem condition/interval. The more remains located, and therefore examined, the more accurate the analysis.*

Tip #6: *DNA Phenotyping is similar to facial reconstruction or approximation in that the prediction of physical appearance in the form of a facial image is produced. Phenotyping is different than conventional reconstruction in that the image produced is based on the subject's DNA profile (genotyping), as opposed to, anthropological evaluation and generalized anatomical features based on age, gender, and ethnicity.*

Tip #7: *Palynology is the study of pollen, spores, and other microscopic grains and organisms. The field is associated with botany and geologic studies.*

Botany (plant life) and Pedology (soil) – Roots, moss, turf, trees, other plant life, and soil can all be useful in some complex death and cold cases. Similar to plants and soil, pollen can prove or disprove relationships among items and people. Pollen is unique to regional areas throughout the country. In the case of a “dumped body” event, pollen found on the decedent’s clothing could aid in locating the area(s) the person resided and/or traveled through. This is especially important when a deceased person is found in or along connecting bodies of water or off of major roadways.

Isotope Analysis (Chemistry) – A complex scientific technique that can aid in resolving certain complex death and cold cases (and perhaps some non-death/cold cases). The technique is based on the fact that the water we drink and the food that we eat are regionally unique throughout the world. The stable isotopes in the water and food settle in our bodies. By having certain parts of the body chemically tested—like muscle, bone, teeth, and fingernails—we may be able to learn where the unidentified decedent resided weeks, months, or years prior to death. Like botany or pedology, this is another science that helps direct or focus an investigation.

Entomology – The study of insects. In forensic science, entomology primarily helps an investigator learn postmortem interval—the time of death until the time of discovery. Insect invasion of decomposing biological material is well documented, and insect reproduction and development are measurable—aiding an entomologist in determining the postmortem interval.

Tip #8: *Form a relationship with a local forensic entomologist. While crime scene investigators can document the required data and collect the required insects to aid an off-site entomologist make certain determinations, more will be learned by having an entomologist visit the scene to acquire the required items.*

Forensic Genealogy - Similar to DNA phenotyping, genealogy is a science that is relatively new to cold cases. Forensic Genealogy was traditionally concerned with probate matters, adoption issues, and family history, but has taken a dramatic leap into the criminal justice system and medico-legal death investigation field due to several high-profile cases that benefitted from its use. DNA profiles used in Forensic Genealogy are different than the DNA profiles used in contemporary police work to identify suspects or human remains. This means that additional DNA testing will need to be conducted on samples used for genealogy purposes. The required testing is not completed by laboratories typically used for law enforcement—like a state crime lab, the FBI’s lab, or the University of Northern Texas Center for Human Identification. This means that a law enforcement agency interested in using this technique would have to contract with a private laboratory that can provide this type of testing. Once the DNA profile suitable for genealogical work is obtained, the law enforcement agency would have to locate a genealogist that would upload the newly developed DNA profile into accessible ancestry databases. Typically, these are not the commercial genealogy services commonly advertised on television, radio, and social media. They are genealogy databases open to the public (i.e., GEDmatch and Family Tree DNA). If kinship information is learned from comparing the newly developed DNA profile to the databases, the genealogist(s) will conduct research and analysis to identify closely related family members of the individual represented in the DNA profile. This process can also be aided by law enforcement using available resources like a crime analyst.

Once that is completed, the kinship information is provided to the law enforcement agency for further investigation and collection of confirmatory samples that will be analyzed through conventional DNA testing. Forensic Genealogy has had several notable successes, but the amount of cases that were not furthered by its use is unknown at this time. A formal program establishing policies and procedures similar to submitting evidence to a state crime laboratory are not currently available.

Conventional Forensic Sciences

Cold case investigations benefit from the use of advancements in conventional forensic sciences like pathology, odontology, toxicology, and radiology. Establishing a relationship with your Medical Examiner or Coroner (ME/C) is imperative to the effective investigation of complex death and cold cases, as defined in this series. As earlier stated, an investigator must know what is possible and what is not from forensic sciences. As an example, familiarizing oneself with the local ME/C procedures and protocols surrounding unidentified human remains (fleshed, skeletal, and incomplete remains) can aid in identification. Also, understanding national guidelines for such cases is helpful. Understanding why the cause and/or manner of death was ruled “undetermined” can aid in reversing this unpreferable status. Often times, legal sensitivities and blind adherence to precedent from ME/C bring about these rulings. Sometimes lack of police investigation contributes to them. Understanding what forensic pathology can and cannot offer is a key to resolving these types of cases. As an example, if you know that the local ME/C buries or cremates unidentified decedents before a full DNA profile from the remains is developed or before the DNA profile runs a full cycle in CODIS (nuclear and mitochondrial DNA) then you can make a request to retain the remains in an appropriate place until the DNA testing is complete.

Forensic Pathologists can also review past autopsy reports and associated documents to further cold cases. The case review can help navigate through historic medical jargon, clarify previously used medical techniques, and identify errors or confirm accuracy. Similarly, forensic odontologists can review dental charts and radiographs for accuracy.

Tip #9: Correcting a single miscoded tooth in the National Crime Information Center (NCIC) database can change investigative outcomes.

Computer Technology as Forensic Science

Computer technology is a primary scientific method used to further unresolved cases. Databases like the National Institute of Justice's (NIJ) National Missing and Unidentified Person System (NamUs), Federal Bureau of Investigation's (FBI) Violent Criminal Apprehension Program (ViCAP) and the National Crime Information Center (NCIC) are all examples of using computer technology in investigations. The proper use of these databases can generate leads from across the country on several cases detailed in this series. The data analysis provided by these services was simply not available ten, twenty, or more years ago. Investigators must understand that once case information is added to these databases they require monitoring and continued evaluation. If information is added today and no actionable leads are found that does not mean the entry was a failure. Tomorrow, next week, or next month another user may enter data that furthers the case giving validity to the need for continued monitoring.

There have been many advances in mapping/surveying equipment in recent years. This technology, like databases, is a science that can be applied to many subfields of investigation. For example, mapping items from an historic crime scene using modern processes can make previously unseen patterns known.

Tip #10: NCIC offline searches are a great tool for cold case investigators. Offline searches provide information from data and queries from law enforcement that are no longer available on the NCIC server. This means that law enforcement can no longer view it (purged) unless a request is made directly to NCIC staff. Also available are non-unique personal descriptor searches, partial information searches, and transaction log searches.

The identified scientific methodologies and technologies, along with their descriptions and tips, are not the only sciences used to further complex death or cold case investigations. There are others that can be used depending on the specific case facts and circumstances. In addition, certain professions utilize science to fulfill vocational duties and can be used to further investigations. As an example, funeral directors have been utilized to restore severely damaged and decomposed facial flesh to aid in identifying a decedent. The human remains had no skeletal structure due to severe trauma, but the facial tissue remained, though distorted and decayed. A funeral director is not a scientist, but the profession allows for the application of scientific principles to industry standards. Keep in mind that scientific evidence intended

to be utilized at a court trial will be subject to Daubert Standards or Frye General Acceptance Test. Both are rules of evidence regarding the admissibility of expert witness testimony.

Solvability Matrix

Solvability factors are information about an incident that aid in “clearing and closing” the case. It is known from working investigations that three items solve crimes—physical evidence, witnesses, and confessions. Solvability factors break those items down to specific tasks that are routinely performed during all investigations. The more factors obtained, the more likely a case is solved. Establishing solvability factors, like Victimology, is something done without really thinking about it. Learning the identity of a suspect through conducting neighborhood canvasses, evidence collection, and/or photo lineups are all ways to add to the solvability of a case, but really these items are just proper investigative steps. Similarly, learning about a victim can aid in locating the offender—which is the point of conducting a Victimology Survey. These steps are taken because they further the case and without thinking about the formal process.

A Solvability Matrix is a document, similar to a checklist, that an investigator uses to determine how likely an investigation can be resolved. This is usually done by awarding points to multiple factors and then adding all of the points together. The higher the points, the more solvable the case should be. A Solvability Matrix in a cold case setting can be extremely helpful for several reasons. First, when a cold case investigator or unit is tasked with investigating dozens and dozens of cases, it can help focus the resources of the unit by identifying the cases that are more “solvable” than others. For obvious reasons, the investigator or unit should begin investigating the more solvable cases first and less solvable ones later. Secondly, in Part 2 of this series—**“Forming a Cold Case Unit and Unit Expectations”**—the author talks about “Getting Organized” when contemplating unit formation. If done properly, the matrix forces the investigator to prepare the case file and relevant case items for active investigation. It also makes for a very professional cover sheet for open cases when presenting the idea of forming a cold case unit to decision makers. The downside to the Solvability Matrix, depending on the department’s case management skills, is that it can be time consuming. Locating and reviewing all of the documents and evidence contained in a historic case can be challenging.

To support the investigation and solvability of a cold case investigation, a Solvability Matrix (see **Annex A**) was created as an adaptable point scale checklist that an investigator or unit can amend and tailor as needed. Each cold case is different and therefore, solvability factors can change. As an example, facial reconstruction is not important in all cases—similarly, not all cases are DNA centered. In some cases, a court reported statement, along with non-DNA trace evidence will be available. Examining the totality of items available in any one case is critical to establishing solvability.

Annexes

Annex A: Solvability Matrix

Department
/Unit Logo
Here

ANYTOWN POLICE DEPARTMENT INVESTIGATIONS SECTION/COLD CASE UNIT

123 MAIN STREET, ANYTOWN, ANYSTATE 12345

TELEPHONE: (123) 555-4567

COLD CASE SOLVABILITY MATRIX

Original Jurisdiction:		Case Report Number:	
Date of Incident:		E.T. Job Number:	
Victim(s):		Location(s) of Incident:	
Detective Review By:		Evidence Technician Review By:	
Date of Review:		Date of Review:	
Evidence Submitted to Crime Laboratory:	☐ Yes ☐ No	Date of Evidence Submission:	
Case Status:			

Case Synopsis:

EVIDENCE

Fingerprints Recovered
Positive Identification(s) through AFIT
Fingerprints Available for All Involved Persons
Trace Evidence Recovered for DNA analysis
DNA profile obtained from analysis
DNA sample obtained from suspect(s)
Weapon(s) recovered
Projectiles/Casings recovered
NIBIN positive identification(s) made
Stolen property entered in LEADS/NCIC

SCORE

	(5 points)
	(3 points)
	(2 points)
	(3 points)
	(5 points)
	(3 points)
	(4 points)
	(2 points)
	(3 points)
	(3 points)

VICTIM

Victim Identified
Victimology completed

	(4 points)
	(4 points)

INFORMANT(S)

Informant(s)/SOI available to assist

	(4 points)
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WITNESS(ES)

Eyewitness(es) to the crime available
Circumstantial Witness(es) available for interview
Involved Police Personnel available for interview

	(5 points)
	(3 points)
	(3 points)

SUSPECT(S)

Suspect(s) identified by witness(es)
Suspect(s) developed by investigation
Suspect(s) residing or working locally

	(5 points)
	(5 points)
	(5 points)

CASE DOCUMENTS

Case Reports
Physical Evidence documents
Scene photographs
Medical Examiner/Coroner reports
Case Notes/General Progress Report notes
Telephone/Social Media Records
A/V Records/Statements
Grand Jury Testimony
Criminal/Civil Testimony
NamUs/ViCAP submitted

	(3 points)
	(3 points)
	(3 points)
	(3 points)
	(4 points)
	(3 points)
	(4 points)
	(4 points)
	(3 points)
	(3 points)

Solvability Points

Annex B: Glossier of Terms

Advanced Fingerprint Identification Technology (AFIT) – deployed in February 2011 as part of the FBI's Next Generation Identification (NGI) system, AFIT replaced the legacy Automated Fingerprint Identification System (AFIS) segment of the IAFIS. AFIT enhances fingerprint and latent processing services which increased the accuracy and daily fingerprint processing capacity, and improved system availability.

Anthropology - the study of human beings and their ancestors through time and space and in relation to physical character, environmental, social relations, and culture

Alcohol, Tobacco, Firearms, and Explosives (ATF) – a law enforcement agency in the United States' Department of Justice that protects our communities from violent criminals, criminal organizations, the illegal use and trafficking of firearms, the illegal use and storage of explosives, acts of arson and bombings, acts of terrorism, and the illegal diversion of alcohol and tobacco products

Archaeology - the scientific study of material remains (such as tools, pottery, jewelry, stone walls, and monuments) of past human life and activities

Ballistics - the science of the motion of projectiles in flight, the flight characteristics of a projectile, the processes within a firearm as it is fired, and the firing characteristics of a firearm or cartridge

Biometrics - the measurement and analysis of unique physical or behavioral characteristics (such as fingerprint or voice patterns), especially as a means of verifying personal identity

Botany - a branch of biology dealing with plant life

Combined DNA Index System (CODIS) – operated by the FBI laboratory, the system blends forensic science and computer technology into a tool for linking violent crimes. It enables federal, state, and local forensic laboratories to exchange and compare DNA profiles electronically, thereby linking serial violent crimes to each other and to known offenders. Using CODIS, the National Missing Persons DNA Database also helps identify missing and unidentified individuals.

Daubert Standard - a rule of evidence regarding the admissibility of expert witness testimony

Deoxyribonucleic acid (DNA) – a nucleic acid that is the main constituent of the chromosomes of all organisms (except some viruses)

Entomology - a branch of zoology that deals with insects

Federal Bureau of Investigations (FBI) - a law enforcement agency in the United States' Department of Justice that is an intelligence-driven and threat-focused national security organization with both intelligence and law enforcement responsibilities. It is the principal investigative arm of the U.S. Department of Justice and a full member of the U.S. Intelligence Community.

FBI's Violent Criminal Apprehension Program (ViCAP) - the largest investigative repository of major violent crime cases in the U.S., it is designed to collect and analyze information about homicides, sexual assaults, missing persons, and other violent crimes involving unidentified human remains.

Frye standard – also known as the Frye test, it is the general acceptance test to determine the admissibility of scientific evidence. It provides that expert opinion based on a scientific technique is admissible only where the technique is generally accepted as reliable in the relevant scientific community.

Forensic - relating to or dealing with the application of scientific knowledge to legal problems

Forensic Pathologist – a medical doctor (usually a pathologist) that focuses on determining the cause and manner of death by examining a corpse. The exam, referred to as a post-mortem or autopsy, is performed during the investigation of criminal law cases and civil law cases in some jurisdictions.

Genealogy - the study of family ancestral lines

Genotyping - all or part of the genetic constitution of an individual or group

Integrated Automated Fingerprint Identification System (IAFIS) – operated by the Criminal Justice Information Services (CJIS) Division of the FBI since its inception in July 1999, it is the national, computerized system for storing, comparing, and exchanging fingerprint data in a digital format.

Mitochondrial DNA - an extranuclear double-stranded DNA found exclusively in the mitochondria of a cell that is maternally inherited - abbreviation mtDNA

Next Generation Identification (NGI) System – operated by the Criminal Justice Information Services (CJIS) Division of the FBI, it was developed and incrementally integrated to replace the IAFIS. The new system provides the criminal justice community with the world's largest and most efficient electronic repository of biometric and criminal history information.

National Integrated Ballistic Information Network (NIBIN) – an ATF program that automates ballistics evaluations and provides actionable investigative leads in a timely manner, it is the only interstate automated ballistic imaging network in operation in the United States and is available to most major population centers in the United States.

National Crime Information Center (NCIC) – operated by the Criminal Justice Information Services (CJIS) Division of the FBI, it was launched on January 27, 1967. It has been referred to as the lifeline of law enforcement—an electronic clearinghouse of crime data that can be tapped into by virtually every criminal justice agency nationwide, 24 hours a day, 365 days a year. It helps criminal justice professionals apprehend fugitives, locate missing persons, recover stolen property, and identify terrorists. It also assists law enforcement officers in performing their duties more safely and provides information necessary to protect the public.

Nuclear DNA – the DNA contained within each cell nucleus of a living organism. Nuclear DNA encodes for the majority of the genome in living organisms, with mitochondrial DNA and plastid DNA coding for the rest. Nuclear DNA adheres to Mendelian inheritance, with information coming from two parents, one male and one female, rather than matrilineally (through the mother) as in mitochondrial DNA.

National Institute of Justice's (NIJ) National Missing and Unidentified Person System (NamUs) – a national information clearinghouse and resource center for missing, unidentified, and unclaimed person cases across the United States. Funded and administered by the National Institute of Justice and managed through a cooperative agreement with the UNT Health Science Center in Fort Worth, Texas, all NamUs resources are provided at no cost to law enforcement, medical examiners, coroners, allied forensic professionals, and family members of missing persons.

Odontologist - a specialist in odontology, a forensic dentist

Odontology - a science dealing with the teeth, their structure and development, and their diseases

Phenotype - the observable properties of an organism that are produced by the interaction of the genotype and the environment

Pedology - soil science

Palynology - a branch of science dealing with pollen and spores



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