REAL-TIME DNA
THE FUTURE OF CRIME SOLVING

by

Scot Collins
Riverside County Sheriff's Department

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The Command College Futures Study Project is a FUTURES study of a particular emerging issue of relevance to law enforcement. Its purpose is NOT to predict the future; rather, to project a variety of possible scenarios useful for strategic planning in anticipation of the emerging landscape facing policing organizations.

This journal article was created using the futures forecasting process of Command College and its outcomes. Defining the future differs from analyzing the past, because it has not yet happened. In this article, methodologies have been used to discern useful alternatives to enhance the success of planners and leaders in their response to a range of possible future environments.

Managing the future means influencing it—creating, constraining and adapting to emerging trends and events in a way that optimizes the opportunities and minimizes the threats of relevance to the profession.

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Crime lab, Shmime lab. Who needs it. I've got my *smart phone*.

DNA technology is currently used to connect a suspect to a crime scene, identify a decomposed body, determine paternity, and countless other uses. The results from the lab, however, can take days, weeks, or even months. Your mobile phone, though, may have some interesting law enforcement applications in the near future.

A police-only DNA device and application, for example, will connect to your smart phone's USB port. To use it, take a sample of blood left at a crime scene with a cotton swab, place the swab into the fold-out tube attached to the device, which is plugged into the bottom of the phone, and then just touch the icon. Viola! The name and drivers license photo of the person whose blood was left at the crime scene appear on your phone!

The wait will soon be over. Real-time DNA will mean real fast results to these important scientific tests.

The technology is here

Real-time forensic DNA analysis is a concept that has recently begun to move to reality. A joint group of graduate students in bioengineering from the University of California San Francisco and University of California Berkeley developed an integrated lab-on-a-chip system. A mock crime scene was prepared by the Palm Beach County Sheriff's Office in Florida with their cooperation in the project. The students were able to complete blood stain sample collection, DNA extraction, typing, analysis, and ultimately

generate a mock Combined DNA Index System (CODIS) hit on a suspect within six hours, all while on-site.[1] When compared with current means commonly seen throughout our nation, this represents a time savings of about two months for a typical case. What does this mean to the law enforcement community on the job today? Read on.

Most of us know that DNA can be obtained from blood, semen, hair, saliva, or skin left at a crime scene, as well as bones or tissue from the remains of a dead body. We have also heard the term, CODIS, but what exactly *is* it? The Combined DNA Index System (CODIS) is an FBI-administered federal database; formally established following the DNA Identification Act of 1994. CODIS contains six indexes: Convicted Offender, Forensic (eg: semen and blood from crime scenes), Arrestees, Missing Persons, Unidentified Human Remains, and Biological Relatives of Missing Persons. The last three of these indexes comprise the National Missing Persons DNA Database.[2]

CODIS databases also exist at some state and local levels. These state and local labs can maintain their own databases, yet still search for matches at the national level. According to a 2009 examination of forensic science in California by the California Crime Laboratory Review Task Force, many state laboratories, however, have a backlog of cases.[3] The study states that, as investigators are becoming more aware of the capabilities of DNA technology, the DNA request submissions for cold cases, post conviction cases, and property crimes cases have increased. This has created a bigger demand on laboratories, resulting in a backlog. While the increasing case load has had a negative impact on turnaround time, the Laboratory Review Task Force's report notes that technological advances have countered that effect.[4]

Crime scene applications

Let's take an example of a female college student who fights off an attack from an unidentified dorm room intruder. The bad guy flees the scene before police arrive. Suspects who leave the scene prior to the discovery of the crime can get a head start on law enforcement. From property crimes to murder, as the clock tics, the case grows colder, and the suspect may be getting further away, destroying other evidence, or worse yet, victimizing someone else. In this case, though, he left something behind.

A police crime scene technician is able to recover pieces of the suspect's skin from under the victim's fingernails. Can we submit this sample to the lab for DNA analysis? If so, how long would the results take in today's world? This scenario would take from about two weeks to two months in most jurisdictions. According to the California Crime Laboratory Review Task Force, the average case turnaround time for crime labs in California in 2008 was 99 days.[5] Real-time DNA will cut down on the head start that our suspects have.

So, our dorm room intruder of the future will be identified with real-time DNA by a hand held computer that the crime scene technician will carry to the scene. Law enforcement officers will have the name of the suspect within minutes and will be able to follow up immediately. This will be very similar to today's portable mobile devices that can make a real-time identification with a person's fingerprints – a profound, cutting-edge idea fifteen years ago. But our database of fingerprints had long been established; we may face a tougher road with DNA.

Who is this dead guy?

Detectives have been called to the scene of a dead human body found dumped in a remote area. The body is so decomposed that it looks like a pile of guacamole – completely unrecognizable. Who is this person and how did he or she die? The key to many of these questions may be in identifying the body.

Occasionally, law enforcement officers are called to a scene where some bones have been unearthed. Are they animal or human? Did we uncover a homicide or is this the remains of someone's long deceased family pet? Real-time DNA will provide the answer right at the scene, without the need for calling in an expert for anthropological analysis.

According to Deborah Gray, a nationally recognized and published forensic anthropologist, the identification of decomposed, charred, or skeletonized remains can often be a lengthy and arduous process.[6] Further complicating the process is that existing technologies such as fingerprints, dental comparisons, and skeletal x-ray comparisons all have limitations. They also may take an inordinate amount of time and effort. With current technology and resources, it could take months to come up with an identity.

According to Gray, state and federal DNA databases use varying types of DNA sequencing, depending on the purpose of each. The National DNA Index System (NDIS) uses a type of DNA sequence called Short Tandem Repeat (STR) taken from the nucleic DNA. She said a benefit of STR is that it is not directly linked to any genetic code or medical condition. The National Missing Persons DNA Database and the California Missing Persons DNA database, though, use sequencing called Mitochondrial DNA (mtDNA) in addition to STR. Today's technology prevents the ability for a one-time

query to all databases for a match with DNA from a deceased subject. This is because nucleic DNA is found in the nucleus of a cell, mtDNA is found in the mitochondria outside the nucleus; they also use different markers. If six characteristics of a decedent are known (sex, stature, race, approximate age, hair color, eye color), the DNA can be compared blindly to all samples in the database with the same characteristics.

Back to our pile of guacamole.

Add real-time DNA technology to the mix and we will get an instantaneous i.d. on the dead guy. Our future technology will allow the coroner to identify the remains on scene and share the information with detectives. As soon as detectives learn of their dead guy's identity, they will start following up on leads by checking his background, interviewing family, friends, and coworkers, searching his residence and car, etc. With today's technology, these investigative steps would be delayed; important evidence could have been destroyed. For better or for worse, however, the government already has access to such uniquely identifying information.

Big brother has the information.

Most states retain small spots of blood from newborns, often called heel stick blood. These blood samples are taken from all newborn babies to check for certain diseases. Many states are using the retained blood samples for medical research, after removing identifying information.

A recent story on CNN titled, *The government has your baby's DNA*, leads readers to believe that state governments are storing the DNA profile of all babies, rather than just the heel stick blood samples, from which DNA could be extracted.[7] Most states destroy the samples after 3 to 6 months. Currently, though, 15 states retain these blood

samples anywhere from 21 years to indefinitely.[8] Similar articles in the Associated Press and the Texas Tribune highlight the ethical controversy over retaining these blood samples, specifically for a federal mtDNA database that does not contain specific identifiers, but is used to narrow down genetic lineage to help identify destroyed or decomposed human remains.[9, 10] The big problem here lies in the ability to establish a complete database.

The future potential of these heel stick samples to be converted to DNA profiles could solve many law enforcement problems *if* the public approves it. This is a very big if. Currently, the State of California, Department of Health and Human Services has heel stick blood samples from over 15 million babies, all born after 1981. From these samples, DNA was extracted to identify two of the eleven serial murder victims in the infamous Ng/Lake sexual torture and murder spree in Calaveras County, California from 1984 to 1985.[11] Although the American Civil Liberties Union has not published a stance on government retention of heel stick blood, the organization is opposed to storing DNA profiles of arrestees and "other innocent persons" who have not been convicted, calling it a grave threat to privacy and the 4th Amendment.[12]

Government agencies' ability to collect and store DNA information on the general population will continue to be a looming public concern. DNA profiles may contain personal genetic information on race, ethnicity, and predisposition to certain diseases and medical conditions. Privacy issues, data security and integrity, employee training, and ethical standards should all face a high degree of scrutiny and criterion for those agencies that wish to position themselves for this future technology.

With no database, why will this matter?

Without a massive DNA database of the general population, we still have CODIS, which is a huge database. Some states are expanding their database to include DNA of certain misdemeanants in addition to all felons. Don't forget, a portion of CODIS also includes the Missing Person DNA Database.

As complex software becomes more prevalent, the possibility of a hybrid system for identifying decedents seems the likely outcome. An intelligent kinship analysis program that queries and compares multiple databases that contain the physical descriptions of missing persons, dental charts, tattoos, medical abnormalities, surgical scars, implants, dates and times last seen, geographical information, and lastly, DNA information, will allow medical examiner or coroner's staff to accurately identify found remains. Advancements will also allow for a blind comparison of one sample profile to an entire database, rather than the current, tedious one to one comparisons.

Our computers are getting smaller every year, and they do more. As each year passes, the amount of technology and speed in our handheld computers, phones, and laptops increases – at times exponentially. This progression, when mixed with increased speed of DNA typing and analysis will result in handheld computers capable of real-time DNA analysis and results at the scene of a crime. It will also allow for a blind comparison of any sample to all indexes within CODIS.

With real-time DNA, our future homicides, assaults, unidentified bodies, and crime scenes will all see a faster resolution and higher closure rates. All this, and a smart phone, too…

[1] Peng Liu, et al., "Real-time forensic DNA analysis at a crime scene using a portable microchip analyzer," *FSI Genetics* 2, no.4 (September, 2008) 301-9.

2 Federal Bureau of Investigation. CODIS Combined DNA Index System, 28 March 2010.

http://www.fbi.gov/hq/lab/html/codisbrochure_text.htm

3 California Crime Laboratory Review Task Force. "An Examination of Forensic Science in California." Page xx, November, 2009.

4 California Crime Laboratory Review Task Force. "An Examination of Forensic Science in California." Page xx, November, 2009.

5 California Crime Laboratory Review Task Force. "An Examination of Forensic Science in California." Page xx, November, 2009.

6 Deborah Gray, interview by author, Perris, Ca, 6 January 2010.

[7] Elizabeth Cohen. "The government has your baby's DNA." CNN.com, February 4, 2010,http://www.cnn.com/2010/HEALTH/02/04/baby.dna.government/index.html?hpt=C2 (accessed March 17, 2010).

[8] National Newborn Screening and Genetics Resource Center. http://www2.uthscsa.edu/nnsis/reportlabspecimen.cfm?reportyear=2009 (accessed 17 March 2010).

[9] Lauran Neergaard, "Spot decision." *Associated Press*, February 24, 2010.

[10] Emily Ramshaw, "DNA Deception." *The Texas Tribune*, February 22, 2010,

[11] Leslie Gaffney, interview by author, Sacramento, California, 16 March, 2010.

[12] American Civil Liberties Union. http://www.aclu.org/technology-and-liberty/forensic-dna-databanks (accessed 30 March 2010).

References

American Civil Liberties Union. http://www.aclu.org/technology-and-liberty/forensic-dna-databanks (accessed 30 March 2010).

California Crime Laboratory Review Task Force. "An Examination of Forensic Science in California." November, 2009 (pg. 73)

Cohen, Elizabeth. "The government has your baby's DNA." CNN.com, 4 February, 2010, http://www.cnn.com/2010/HEALTH/02/04/baby.dna.government/index.html?hpt=C2 (accessed March 17, 2010).

Federal Bureau of Investigation. CODIS Combined DNA Index System. 28 March 2010.

http://www.fbi.gov/hq/lab/html/codisbrochure_text.htm

Gaffney, Leslie. Interview by author. Sacramento, California, 16 March 2010.

Gray, Deborah. Interview by author. Perris, CA 6 January 2010.

Liu, Peng, Stephanie H.I. Yeung, Karin A. Crenshaw, Cecelia A. Crouse, James R. Scherer, and Richard A. Mathies. "Real-time forensic DNA analysis at a crime scene using a portable microchip analyzer." FSI Genetics 2, no.4 (September, 2008) 301-9,

National Newborn Screening and Genetics Resource Center. http://www2.uthscsa.edu/nnsis/reportlabspecimen.cfm?reportyear=2009 (accessed March 17, 2010).

Neergaard, Lauran, "Spot decision." *Associated Press*, February 24, 2010.

Ramshaw, Emily, "DNA Deception." *The Texas Tribune*, 22 February, 2010.