The Case for Rapid DNA

The latest breakthrough in DNA forensics, Rapid DNA analysis, is expected to be a game-changing technology in crime fighting. The acceptance and use of DNA in forensics has been increasing in recent years, and studies of real-world examples indicate that it is a powerful and cost-effective weapon in the law enforcement arsenal. Rapid DNA promises to revolutionize the use of DNA by making it a routine identification and investigational tool.

DNA in Forensics: A Brief History

It was in 1984 that pioneering British scientist Sir Alec Jeffreys realized that DNA profiles—snippets of DNA that tended to vary significantly from one person to another—could be used as genetic fingerprints to tell people apart. That breakthrough was quickly put to task in criminal investigation: in 1986, a baker named Colin Pitchfork in Leicestershire, England, became the first person ever convicted based on DNA evidence. 

Genetically speaking, every person is nearly identical, sharing more than 99 percent of the DNA that makes us human. It’s that remaining fraction of a percent that makes each person unique. In forensics, analysts home in on a predefined set of regions of DNA known to vary among individuals. That set of regions—in the U.S., 13 snippets of DNA chosen as a standard by the Federal Bureau of Investigation—works just like a set of DNA fingerprints, clearly distinguishing one person from anyone else. The odds that any two people would have identical DNA snippets at all 13 match points are less than one in a billion.

Today, DNA evidence has been used in the U.S. to convict thousands of violent criminals—and, just as importantly, to exonerate hundreds of people who were mistakenly convicted. DNA is widely recognized as one of the most effective tools in the investigative and prosecutorial arsenal. The most recent advance, “Rapid DNA” technology, automates an otherwise multi-step process that requires specialized expertise and a laboratory to deliver results in less than 90 minutes using a self-contained system. Rapid DNA is poised to make DNA analysis an even more valuable asset in identification and in crime solving by paving the way for its use as a powerful investigative tool.

Beyond Violent Crimes

In the 25 years since DNA became a factor in criminal convictions, the tool has been deployed mostly for violent crimes—homicides and sexual assaults—where it is thought that criminals are likely to leave genetic evidence behind. In 2010, there were just over 99,500 homicides and forcible rapes reported in the U.S. (FBI Uniform Crime Report).

But more recently, some police agencies have started to use DNA as an investigative tool in property crimes as well. Property crimes are far more numerous than violent crimes; in 2010, there were 2.2 million burglaries estimated in the U.S. (FBI). DNA samples can be found at crime scenes in a variety of sources: blood, cigarette butts, and hair are some common examples.

In 2003, the New York Police Department launched the Biotracks program to begin using DNA evidence to solve burglaries (Calandro, 2010). The vision for the program was to treat burglary as a serious crime and to treat those scenes the same way they treated violent-crime scenes. Adding DNA to the investigation quickly enabled police officers to solve cases that had no suspects and would otherwise have languished, likely never to be solved. Indeed, by late 2007, some 15 percent of all cases in the program yielded DNA that matched an offender (Foreman, 2011).

Beyond the obvious advantage of finding the perpetrator behind property crimes that would otherwise go unsolved, the major benefit of adding DNA to the investigation was that it helped to break the crime cycle by getting offenders off the street faster. New York City Police Detective Sgt. Joe Blozis commented, “The common denominator amongst violent felons was burglary. If you could take the burglar off the street, ultimately, you’re going to save lives. Today’s burglar could be tomorrow’s robber, rapist or killer. The whole DNA processing area reduces crime and saves lives. DNA is a very, very powerful law enforcement tool.” (Foreman).

Another key finding of New York’s Biotracks program—and one which has been supported by results of similar programs in the U.S. and U.K.—is that when DNA evidence is found at a property crime scene, it tends to match offenders who have more prior arrests and more violent crime convictions. In other words, adding DNA as an investigational tool gives law enforcement officers
a better chance of catching the more violent repeat offenders, getting those criminals off the streets who would be most likely to cause major harm in the future. Studies on the use of DNA in property crime investigations have generated insight into the economics associated with employing this technology. The FBI estimates that the average dollar loss per burglary offense is $2,119, while the National Institutes of Justice (NIJ) estimates that the top 10 percent of burglars commit more than 232 burglaries per year apiece. Among the top 10 percent of burglars, then, the estimated dollar loss is at least $491,608 per burglar per year. In a report of the results of the DNA Field Test by the Urban Institute, analysts determined that the addition of processing DNA evidence for an individual case cost about $1,400—or about 3 percent of the economic damage done by a single prolific burglar in a year.

Case Study: The DNA Field Test

Based on success in the U.K. with adding DNA testing to property crime investigations, several communities in the U.S. were funded by the NIJ to perform large-scale pilot studies. The DNA Field Test, as it was known, began in late 2005 and concluded in 2007, with study results analyzed and reported the following year. Participating communities included Orange County and Los Angeles, California; Topeka, Kansas; Denver, Colorado; and Phoenix, Arizona.

What had been found in the U.K., where the British Home Office had been using DNA analysis since 2001 for non-violent crime investigations on a national scale, was that the approach vastly improved suspect identifications (41 percent in cases with biological evidence, compared to just 16 percent in cases without DNA). An analysis by the Home Office also noted that DNA bested the physical fingerprint as an accurate identifier: while more fingerprints were found at more crime scenes, DNA samples were almost twice as likely to match to a database than fingerprints were, significantly improving offender identification (Home Office, 2005).

Results from the DNA Field Test were just as encouraging. The test began with the five communities’ law enforcement officers collecting biological samples for as many as 500 crime investigations during a two-year collection period. These cases were then randomly split in half, with one group serving as a control—any collected DNA would not actually be processed or included in the investigation—while the other group actively included DNA in its investigations (Roman, 2008).

In their assessment of the program, the Urban Institute analysts concluded that DNA was an important tool in identifying offenders who would not otherwise be found through traditional crime investigations. Compared to cases that did not use DNA evidence, the study found that property crimes with DNA evidence yielded more than twice as many suspects identified (31 percent versus 12 percent), as well at least twice as many cases accepted for prosecution. Compared to physical fingerprints, DNA evidence was more than five times likelier to result in a

Figure 1: The addition of processing DNA evidence for an individual case cost about 3 percent of the economic damage done by a single prolific burglar in a year.

Figure 2: Property crimes with DNA evidence yielded more than twice as many identified suspects.
suspect identification and nine times likelier to lead to an arrest (Roman).

In their own appraisal of the success of the DNA Field Test, Denver officials—whose program was called the Burglary DNA Project—noted that by the time the project was completed, there had been a 26 percent drop in property crimes in the city. That number is even more noteworthy when compared to a several-year streak before the project during which property crimes increased an average of 5 percent annually. Based on the longer prison sentences achieved with DNA evidence, higher rates of prosecutorial filings that occur with DNA evidence, and the prevention of future crimes committed by those offenders who were put behind bars, Denver officials estimate that the Burglary DNA Project saved their citizens some $29 million (Denver DA).

The Rise of Local DNA Databases

Biological evidence would not be nearly as useful as it is without DNA databases. In some cases, officers may have both the offender and the crime scene evidence to compare the DNA match directly; in this situation, no database is needed. But that is rare. In general, DNA profiles from crime scenes must be uploaded into a database and the database searched; if the offender’s profile is already in the database, there will be a match when the evidence is searched. If there is no match, then the profile sits in the database and waits for another piece of evidence with the same profile or the actual offender’s profile to be uploaded and matched.

In the U.S., the most well-known DNA database system is CODIS, or the Combined DNA Index System, managed by the FBI. CODIS includes DNA profiles uploaded from federal, state, and local forensic laboratories that have been certified or accredited as meeting certain standards for quality control and operating procedures.

The criteria for uploading a DNA profile to CODIS are quite stringent and often require lengthy review periods; in some studies of this process, DNA profiles generated from crime scenes were still awaiting upload to CODIS more than a year later due to these review requirements (Inspector General, 2004). Any matching offender profiles uploaded during that time period would not be linked to this profile evidence, preventing law enforcement agencies from closing those cases and prosecuting those suspects.

For police departments adding DNA evidence to their property crime investigations, the other challenge in using CODIS is that it contains very few profiles from similar, local crimes, since DNA analysis has mostly been restricted to violent crimes. Because of this, a new trend of local databases is emerging: police in some jurisdictions are building their own DNA databases, sometimes with the help of private companies. These databases tend to be jurisdiction-specific, which helps with property crime in particular, as offenders tend to work the same area over and over. They also are not burdened with the CODIS review requirements, so DNA profiles can be uploaded quickly and matches can be found much faster. Proponents say that these local, focused resources are helping police get criminals off the street faster.

Case Study: Bensalem

In Bensalem, Pennsylvania, a community just north of Philadelphia, local law enforcement officials have partnered with DNA:SI Labs, accredited as a private provider of DNA analysis and databases. The company is able to guarantee Bensalem police officers a three-week turnaround time on the evidence or samples submitted—something that most government-funded crime labs are unable to do (Asplen, 2012).

Database Hits from National Versus Local Database

![Figure 3: The local database project in Bensalem generated more than 55 hits on cases for local law enforcement.](image-url)
The local database project in Bensalem has been working for non-violent crimes precisely because offenders in property crimes tend to repeat these crimes in a small geographic region. The faster Bensalem police can get burglars and other offenders off the streets, the more crimes they are able to prevent. In its first two years of use, the database generated more than 55 hits on cases for local law enforcement. By contrast, they saw fewer than 12 hits from the national CODIS database in that same time period (Asplen).

Arrestee DNA Samples

Another important factor in improving DNA databases is adding more offender profiles so that more matches are found for unsolved crimes. U.S. Federal law permits collection of DNA samples from persons arrested or detainted under federal authority (Violence Against Women Act of 2005). Many states have moved to the model of arrestee DNA collection for certain offenses in the same way that police currently gather someone’s name, social security number, photographs, and fingerprints during the booking process. While law enforcement officials contend that this is a proven, expedient way of catching criminals, organizations such as the American Civil Liberties Union argue that DNA collection should take place after conviction, not on arrest.

In studies of the impact of this timing, a number of jurisdictions have determined that many crimes could have been prevented if DNA collection occurred at arrest instead of at conviction. In 2005, the City of Chicago reported to its state legislature that a study of just eight offenders who were arrested but then released for lack of evidence found that those offenders went on to commit 60 violent crimes—including 22 murders and 30 rapes—after being released. The study determined that those 60 crimes could have been prevented if DNA samples had been collected upon arrest. Allowing arrestee DNA collection would have matched the arrested-but-not-convicted offenders to prior crimes for which DNA samples had been recovered and entered in a database awaiting a match (Chicago Study, DNAResource.com).

In Maryland, a targeted study of three offenders demonstrated that 20 crimes could have been prevented if DNA samples had been collected upon arrest. These three offenders were arrested but released; if their DNA had been entered in a database at the time of arrest, officers would have been able to link them to past crimes and the offenders likely would have gone to prison. Instead, in the time between their release and eventual prosecution, the offenders committed 20 more crimes, including murder, rape, burglary, and assault (Maryland Study on Preventable Crimes).

Across six states, case studies of 19 offenders found that 168 crimes could have been prevented by collecting DNA at arrest instead of at conviction.

Challenges in DNA Forensics

Despite the effectiveness of using biological evidence in crime investigations, there are still challenges to implementing DNA forensics at a broader scale. Time and capacity are two of the most serious: between CODIS upload requirements and the volume of samples submitted, many crime labs have more DNA evidence than capacity to test it. In its report on the DNA Field Test, the Urban Institute notes that “crime laboratories are severely constrained in their ability to process biological evidence in volume.” It is not unusual for government crime labs (whether organized at state, county, or local levels) to have backlogs of several months to more than a year to process DNA evidence.

As a result, the idea of adding DNA analysis to property crime investigations raises concerns about overwhelming an already strained lab system. Jurisdictions like Bensalem have decided to work with private labs that can process the samples faster, even if their databases are outside of the CODIS system.

Imminent Availability of Rapid DNA Testing

The latest technology breakthrough in DNA testing for forensics is the development of platforms that can produce a DNA profile, compatible with standard databases, from evidence or a sample in less than 90 minutes, compared to a typical turnaround time of 30 to 90 days. In the U.S., federal agencies or groups including the Department of Homeland Security, Department of Justice, Department of Defense, FBI, and U.S. Army have committed funding to making Rapid DNA possible. Faster DNA analysis could be used for a number of fields,
such as: familial relationship verification in citizenship and immigration; law enforcement investigations; and human remains identification in mass disasters.

Along with the possibility of Rapid DNA results comes the likelihood that samples could be collected by trained police officers in addition to crime scene technicians. In the Bensalem partnership with DNA:SI, officials note that police officers are trained to collect DNA samples and that there has been no detrimental effect of this in downstream analysis of the samples (Asplin). After concluding the DNA Field Test, the Urban Institute analysts reported that DNA collected by police officers or detectives was just as likely to yield useful profiles as DNA collected by crime scene technicians.

The expansion of sample collection will be important as Rapid DNA allows for more powerful applications of DNA testing. For example, this technology could be used to quickly eliminate suspects from an investigation, directing police manpower toward more fruitful avenues. Profiles of arrested offenders could enable police to link criminals to other unsolved cases where DNA evidence had been saved in a database. During a burglary spree, law enforcement agents could determine quickly whether crimes were isolated incidents or part of a pattern by the same offender(s), which would help them put a stop to the crimes faster than if each case had to be investigated independently.

**Case Study: Palm Bay**

Law enforcement officials in Palm Bay, a city of more than 100,000 people in east central Florida, have been early adopters of many advances in DNA analysis. In 2007, Palm Bay contracted with a private lab to build its own local DNA database (Blackledge, 2012). Since then, police in Palm Bay have been using DNA testing as an investigational tool for non-violent crimes, which represented 80 percent of the reported crimes in the city. During the first four years of this program, Palm Bay’s crime rate fell by 25 percent, with a 40 percent decrease in burglaries, and the case clearance rate rose by 269 percent to 35 percent. This is compared to a national case clearance average of 13 percent.

In 2011, the Palm Bay Police Department performed a three-day field trial of a Rapid DNA prototype instrument developed by IntegenX, called the RapidHIT™ system. The technology, which is based on established DNA analysis processes using PCR and capillary electrophoresis, analyzed four samples simultaneously in less than two hours. During the course of the trial, participants analyzed more than 36 DNA samples, including samples that had been stored for up to four years at the police department, and generated full, database-compatible profiles from all of them. The Palm Bay team also installed the RapidHIT instrument in a mobile crime van and used it on-site at a mock crime scene. Members of the Crime Scene Unit analyzed several samples, producing partial profiles that yielded a match in the database. An analysis of the field trial notes that the time elapsed from the arrival of the crime scene technicians to the correct identification of the suspect from the DNA match was less than five hours (Blackledge).

**Get Ready for Rapid DNA**

Rapid DNA analysis is a transformative technology that promises to fundamentally change the way investigations are conducted by enabling law enforcement personnel to quickly and definitively identify suspects while they are still in custody. The technology has the potential to help create safer communities through its many applications from policing to homeland security and defense. With the introduction of the first commercial Rapid DNA systems in 2012, a new standard will emerge in the usage of DNA profiles as an actionable biometric.
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