Volume 15
Spring
2019
djim.management.dal.ca |

Genetic Genealogy and its Use in Criminal Investigations: Are We Heading Towards a Universal Genetic Database?

Emily Plemel

School of Information Management, Dalhousie University

Abstract

In April 2018, Joseph DeAngelo also known as The Golden State Killer was caught and convicted. This was made possible by 40-year-old DNA evidence, genetic genealogy, and current information systems technology. This paper will discuss the history of genetic information such as DNA testing used in forensics, and consider information technologies effect on the future of criminal investigations. The main focus is genetic databases and their management. How will the management of these databases affect the public and law enforcement? Could a universal genetic database create solutions to the current criminal database systems, often critiqued for being discriminatory? How can we use genetic genealogy more efficiently to solve crimes? The sources used for this exploration include companies such as GEDmatch, 23andME, and Ancestry; key players of the field such as Barbara Rae Venter and CeCe Moore; newspaper articles, statistics, and academic journals.

Keywords: DNA, genetic genealogy, cold-case, crime solving, forensic investigation, genetic database, information management, universal database

Lately, a small industry has been gaining attention in the fields of criminal investigation and information management, that is, solving cold cases using genetic genealogy and genetic information databases. Already, there have been a few key players identified in this growing field in North America; Cece Moore, Parabon Nanolabs Inc., Barbara Rae-Venter, Curtis Rogers (GEDMatch), Ancestry.ca, 23andMe, and Paul Holes. You may be wondering, hasn't Deoxyribonucleic Acid (DNA) profiling been used in crime investigations since the 1980s? Yes, it has. However, the processes and results have evolved with the rise of big data and the public's participation in DNA genealogy services. To explore this topic, the focus of this paper will be placed on the changing process in criminal investigations via genetic genealogical evidence, starting with early cases and practices then moving into present procedures and the predictions for the future. I will discuss how the history of genetic information has led to future predictions for a universal genetic database, and how this might function. I will explain how information managers could see the landscape of genetic information and its storage change because of the added value as evidence and its use in the criminal investigation process. I will explore questions such as; what are the benefits and the concerns of considering a universal database for this type of information? But first, to understand how this industry has changed, the current genetic genealogy and investigation process should be understood as follows.

The Procedure as it Currently Stands

To explain the current process I will be consulting information from Parabon Nanolabs Inc., the company from which CeCe Moore operates. This is a summary of the processes that labs or databases such as Parabon Nanolabs use. The first process involved with genetic investigation is genetic genealogy (GG). This entails a combination of traditional genealogical research and genetic analysis. Traditional genealogy research is conducted by using evidential documents such as vital statistics, church records, obituaries, immigration records, land records, biographies, and much more to research family history and map family trees. Genetic analysis is conducted by using DNA information to compare how closely related two individuals are. To break this down, the exact process is done by examining the aDNA, which is different from other genetic markers such as X or Y chromosome DNA because "aDNA is inherited from all ancestral lines and passed on by both males and females and thus can be used to compare any two individuals, regardless of how they are related" (Parabon Nanolabs, 2018). By examining long stretches of DNA genealogists can infer if there is a common ancestor because it is highly unlikely for unrelated individuals to share a long stretch of aDNA. So, how can a stretch of an unknown individual's DNA be compared to other known individual's DNA on a large enough scale that these comparisons can be representative our current population? The answer to that lies in the development of public and private genetic genealogy databases. By using databases such as GEDmatch, Ancestry.ca, or 23andMe, the unknown DNA can be compared to numbers in the millions at a time to check for common relations (Parabon Nanolabs, 2018). This process can help to identify perpetrators as well as unidentified or "Jane/John Doe" murder victims. Currently, this is the process and applications of genetic genealogical investigation. In the past, this practice was very different.

The History of Genetics in Criminal Investigations

In 1999 the International Journal of Offender Therapy and Comparative Criminology published an article outlining predictions for forensic DNA profiling in the 21st century. This article takes us back to the first classification system developed for DNA evidence in 1982 called Galton's Fingerprints. This fingerprinting system is important to recognize because Galton was able to collect a large sample of prints, essentially creating the first system to manage the collection of unique identifying evidence which we can compare to the databases of today (Friedman, 1999). Advancing on from fingerprinting, DNA testing became increasingly common in criminal investigations particularly after the court gave DNA information evidential value with early convictions such as that of Tommy Lee Andrews, which will be discussed shortly.

Typically, when DNA and investigation are thought of in tandem, what comes to mind is fingerprinting or bodily fluid samples. This type of DNA profiling is different than the genetic genealogy profiling done today because it can only trace the parentage DNA. This means that the DNA can only be traced as far back as the parents, or another sample of that specific person's DNA. For example, one of the first cases in North America where DNA evidence of this kind was used in a court of law resulted in a conviction of a serial rapist in 1987. Tommy Lee Andrews was sentenced to twenty-two years in prison for rape, aggravated battery, and burglary primarily based on DNA match evidence. The blood taken from a fingerprint proven to be Andrew's at one crime scene and was matched to the semen taken from another crime scene. However,

the lab couldn't match Andrews' entire genetic code to the rapist's--that would be technically impossible. But technicians could compare representative pieces of the two DNA samples that scientists know are highly variable in the human population (Crenson, 1997).

Unlike the present method of genetic genealogy, Andrew's separate DNA samples were matched to each other to determine that he was present at both the crime scenes because there was a long enough run of matching genetic coding. From this evidence Andrews was "convicted of breaking into the home of a 27-year-old Orlando woman, raping and stabbing her on May 9, 1986" (NYT Staff, 1988). This was a break in the crime solving industry as well as the world of genetics – it meant that DNA could show us information that had evidential value. So, how did DNA evidence and profiling procedures evolve from this breakthrough?

The process of DNA testing that was used in the 1970s-1980s is called Restriction Fragment Length Polymorphism (RFLP). To simplify, RFLP analysis is the process of "cutting a particular region of DNA with known variability, with restriction enzymes, then separating the DNA fragments by agarose gel electrophoresis and determining the number of fragments and relative sizes" (Philips, 2018). The drawback to this method is that the process is time consuming and expensive. Once the process is completed the information from the RFLP tests are compared in an attempt to match the unique information. In cases like Tommy Lee Andrews this confirmed his guilt as the unknown DNA matched his own. On the other hand, it allows for the opposite result like the case of Kirk Bloodsworth, who in 1993 was the first person on death row to be exonerated by DNA evidence. In this case

Bloodsworth was a 22-year-old former Marine when he was wrongfully convicted in 1984 of the rape and murder of a nine-year-old girl, and was sentenced to death in Maryland... Bloodsworth was convicted largely based on misidentifications made by several eyewitnesses (Innocent staff, 2018).

By 1992 the ability to test DNA was a trusted procedure and the DNA from the Maryland case was tested, ultimately proving Bloodsworth's innocence and staying his execution.

In the early1990s scientists made another breakthrough in DNA testing technologies. The process of Polymerase Chain Reaction (PCR) replaced RFLP analysis. This meant that less DNA was required and the results were available much quicker as the test examines the Short Tandem Repeats (SRP) of the DNA which are highly variable making matches more exact and lowers the risk of misidentification.

By the early 2000s PCR technology was improved by combining genetic markers into a singular test. This cut test times even further and created an array of other options for what the DNA could reveal, including "AIMs (Ancestry Informative Markers), Y-Chromosome markers, mitochondrial markers, ancient DNA markers, and other markers useful for establishing more distant biological relationships like 4th or 5th cousins" (DNA Diagnostic Centre, 2018).

In 2015 an article published in the Philosophical Transactions of The Royal Society: Biological Sciences made some predictions of where the field of DNA testing was to go next. The article anticipated that, "DNA protocols can be expected to become more rapid and sensitive and provide stronger investigative potential" (Butler, 2015). Butler was right in his predictions, particularly for stronger investigative potential. The article also addressed the growing need and use for DNA databases noting "the number of samples (both known references and crime scene specimens) involved in DNA databases means that genetic markers used to generate the DNA profiles in those databases will drive the future of DNA testing" (Butler, 2018). These predictions lead us to present day investigation practices, as DNA testing processes and genetic genealogy begin to play a larger investigative role, all made possible by the utilization of the information stored in genetic databases.

Present Use of Genetic Evidence

In 2010 a new DNA testing process was developed called Next Generation Sequencing (NGS) or Massive Parallel Sequencing. The implications and applications of this process are what make the current state of criminal investigation so advanced:

this procedure generates a DNA sequence that is the linear arrangement of letters (A, T, C, and G) that occur in a DNA sample. Because the technique allows one to simultaneously start the sequencing at thousands of locations in the DNA that overlap, massive amounts of data can be generated and put back together with appropriate bioinformatics programs (DNA Diagnostics Center, 2018).

With the amount of data, an ever-growing population, and the rate that this data is produced how can investigators possibly find DNA matches when their own databases only hold information for previous offenders and suspects, or DNA information from previous crime scenes?

With the use of NGS analysis, investigators look to outside databases to run their DNA data against, searching for relativeness in the DNA. These outside databases contain DNA information submitted by the public, big players include: GEDmatch, Ancestry.ca, 23andME, and Genbank. Science News Magazine calculates that "more than 12 million Americans have jumped on the consumer genetic testing bandwagon, sending spit samples to companies like 23andMe or Ancestry DNA to learn about health risks and to explore family origins" (Saey, 2018). Comparing the DNA information submitted to these databases can lead to a direct match, an ancestral, or familial relation. This leads investigators to the perpetrator. This process can be further explained by examining the example of Joseph DeAngelo, also known as The Golden State Killer.

During April of 2018 investigators were able to solve the cold case of the Golden State Killer, a serial killer and rapist who was active from 1974-1986 using genetic genealogy. Investigators used a combination of publicly available DNA databases, prominently GEDmatch, to discover potential matches for the DNA left at the crime scene over 30 years ago. The matches that investigators found led investigators to DeAngelo's third cousins. (Saey, 2018). After discovering the familial matches Barbara Rae-Venter, a genetic genealogist consultant built the unknown suspect's family tree using documents and other evidence dating back to the 1800s. From this, police were able to follow branches of the family tree down to the family that was living near to California during the perpetrators active period. Now their list of suspects was significantly narrowed. They collected DNA of the suspects, some without their knowledge, until they found their match with a 72-year-old former police officer Joseph DeAngelo. In the wake of this case "over 100 crime scene samples have been uploaded to GEDMatch alone [for criminal investigation purposes], and law enforcement have used the same methods to make arrests in similarly serious cold cases, and in at least one active investigation" (Murphy, 2018). Since the arrest and conviction of DeAngelo "suspects in 16 other cases have been arrested after genetic genealogy searches" (Saey, 2018).

This significant spike in the amount of cold cases solved has led to much media attention, producing headlines such as "The Coming Wave of Murders Solved by Genealogy" (Zhang, 2018) and "This is just the beginning: Using DNA and genealogy to crack years-old cold cases" (Snow, K., & Schuppe, J. 2018). There have also been discussions during many podcasts, on social media platforms, and various journals discussing this rising trend. However, these discussions are not always positive.

The Implications of Using Genetic Genealogy in Criminal Investigations

Forensic Science International published an article titled "Damned by DNA – Balancing personal privacy with public safety", which explores the ways that investigations are conducted using genetic genealogy can be problematic. To discuss this it is important to acknowledge that databases such as 23andMe work by having members of the public give consent to their most personal data (DNA) under the knowledge they will of receive a service in return. This often becomes a part of tangible output, such as a DNA profile. These profiles then become a sort of a tool to connect family members, conduct studies, and as previously discussed, solve cold-cases or even current crimes. All these aspects are typically viewed as beneficial. However, "below the surface are questions concerning consent, inclusion of the non-convicted in criminal searches, and the dangers of contamination" (Moran, 2018). Because the crimes being solved using genetic genealogy are most commonly cold-cases, the question of contamination is a high concern. The DNA being used is often twenty or more years old. Cases that happened before 1990 are at a higher risk of contamination, leaving the chance for a misidentified piece of DNA evidence, or even DNA that has become a "mix" because of contamination from past investigators handling the DNA. Moran explains,

mixture interpretation is left to the DNA analyst who must parse out which peaks in *the electropherogram (the chart produced) belong to which person. It is then up to the investigators to decide whether one's inclusion in a profile makes one just a contributor or a potential suspect. Contamination complicates the ability [of the analyst and investigators] to determine which profiles are of relevance and which are not (Moran, 2018).*

In recent conversation around these investigations critics have also brought up concerns about transparency. Benjamin Berkman a member of the Department of Bioethics in the United States explains that the public often doesn't understand "the idea that they upload their data for genealogy purposes and it's used in such a different way" (Berkman quoted by Crist, 2018). Berkman states that the reason for this is "the terms of service agreements don't explain this clearly, and even if they did, people wouldn't read it or find it in the dense legalese" (Berkman quoted by Crist, 2018). This explanation from Berkman summarizes why critics question if these companies are really operating with transparency. Yes, all the information is available, but these companies must know that their users are not necessarily aware of the way their DNA information is being used which includes its use in criminal investigations. This issue has reached the European Court of Human Rights in 2008 when the court

ordered the expungement of hundreds of thousands of DNA records that belonged to people with no criminal conviction. The court said that such records violated the individual's presumption of innocence and that governments should not be able to indiscriminately retain data (Moran, 2018).

The court made this decision so criminally convicted and innocent profiles would not have the same levels of access to circumvent the potential for discrimination. Transparency also plays into issues of consent. As mentioned, the Terms of Service are not always clear enough for users to understand the full usage of their DNA information.

Since investigators are now using databases not specifically made for criminal justice purposes, questions are raised about consent. Have users, in fact, consented to the investigators using their DNA information? Is consent a gray area when it comes to security and justice for the victims of cold-cases such as April Tinsley, whose killer John D. Miller was convicted with genetic genealogy evidence from a DNA database service in July of this year (2018). April Tinsley was abducted, raped, and murdered at the age of 8 in April 1988. After, the killer taunted police and residents of Fort Wayne with mysterious messages, often threatening to act again (Levenson & Watts, 2018). Horrifyingly, this case went cold. More than 30 years later in 2018

Police connected him [John D. Miller] to the homicide by using DNA from the scene of the murder and from the taunting messages, and inputting them into a genealogical database. That led *investigators to two men: Miller and his brother, according to a probable cause affidavit. (Levenson & Watts, 2018).*

Notice that it was not only the perpetrator whose information was retrieved by the DNA search, but also his brother's. This demonstrates the way in which genetic genealogy identifies a "pool" of suspects. Even if an individual did not provide their information to a genealogy service they can be connected to a crime via familial DNA information using genetic genealogy practices. Berkman claims many people send in DNA for genealogy with the expectation of it being a novel idea or for "entertainment purpose" and "people may not realize uploading their DNA could be responsible for a cousin's arrest as well" (Berkman quoted by Crist, 2018). This same genetic information could also be responsible for a misidentification as previously highlighted when discussing the possibility of contamination. Essentially, the concerns around consent are that people using these genealogical services are not entirely aware of what they have consented to; therefore, have they really consented? Legally the answer may be yes, but ethically there are concerns and unknown consequences to the investigators gaining access to information obtained this way and using it in this context. In the future, these questions will continue to arise as genetic genealogy is used more heavily to solve cases.

The Future of Genetic Genealogy as Criminal Evidence

Genetic testing processes have advanced rapidly since the first use of DNA evidence in the early 1980s. These technologies have taken huge leaps, from placing a suspect at the scene of a crime (1980s) to convicting a killer using DNA evidence from 40+ years ago using familial genetic and genealogical mapping (2018). So, where can genetic genealogy and its applications go from here? The first thing that comes to mind is regulation. As of now, there is not sufficient regulation around genetic genealogy databases services. Law enforcement databases such as the Combined DNA Index System (CODIS), the FBI's genetic database, has many regulations in regards to how law enforcement can use and access the information. The regulations include rules such as

A sample labeled a "crime scene sample" is limited to biological evidence from a "putative perpetrator"; police cannot upload profiles derived from evidence that may have a remote connection to the crime, or from a mere witness or bystander (Murphy, 2018).

Only DNA collected as a crime scene sample and from someone considered to be a perpetrator can be collected and stored in CODIS. Now, keeping this in mind it can be seen that genetic genealogy databases differ greatly in regulation and can allow

law enforcement ... to turn to genealogical databases not just to find matches in cold *cases that fail to return any hits in the forensic databases, but also in situations where federal or state laws expressly forbid such searches for quality control or privacy reasons (Murphy, 2018).*

What this means is that genetic data stored in under regulated databases provide law enforcement with a greater pool of genetic information, they are not restrained from using this data by regulations such as those in CODIS. It both provides law enforcement with a bigger resource to use when solving crimes, but also allows for the publicly submitted DNA to be used in crime solving without proper awareness from the public. This is can be seen as a justice tool but also as non-transparent.

The variety of issues with genetic genealogy services regarding privacy, consent, and transparency might be mitigated with regulations heavier than simply Terms of Use statements. One article from a critic states that lawmakers may need to consider creating more regulation because

enacting… protection for genetic data stored in nonforensic databases would ensure that the government cannot subject ordinary individuals to suspicionless genetic searches, while allowing investigators to access genetic data where there is reason to believe a particular individual may be tied to a particular crime (Ram, N., Guerrini, C. J., & McGuire, A. L., 2018).

It may be asked: Can regulation help provide a crime-solving tool while being transparent about it? The authors of Genealogy databases and the future of criminal investigation suggest that a Stored Genetics Act will be necessary in the future because of the concerns already present. They see this conceptualized act as legislature that

would likely render law enforcement searches of nonforensic genetic databases unlawful for crime-detection purposes, as there can be no "specific and articulable" connection between particular database records and a particular crime when investigators seek to use such a search to generate leads, not investigate them. (Ram, N., Guerrini, C. J., & McGuire, A. L., 2018).

However, these regulations may lead to fewer crimes being solved for the sake of the public's privacy.

From the opposite viewpoint, in the article "Is it time for a universal forensic database?" the authors speculate that the time for universal genetic databases is approaching. The universal database is a concept that this article describes as a "DNA database, populated with data from every individual in society, obviating the need for any other DNA source" (Hazel, J. W., Clayton, E. W., Malin, B. A., & Slobogin, C., 2018). The benefits of this proposed database are as follows. The databases of today are split into sectors such as private, public, medical, criminal, and others. If properly implemented, the universal database may be more productive and less discriminatory than the current systems in place because of these divisions. With all genetic information in one database not separated by public or private services and not separated into guilty and innocent, the information is not as divisive. In regards to crime, this collective resource of DNA could speed up the process of generating suspects and convicting felons because investigators would no longer have to first check their own database of known criminals, then check results against a publicly accessible database, and if that fails, check the private databases where issues around privacy become more evident. The same can also be said for the identification of bodies and remains. Hazel et al., also speculates that a database such as this would

virtually erase the government's incentive to conduct long-range familial DNA searches of the type used in the Golden State Killer case. It would thus markedly alleviate the impact on innocent people who happen to be related to criminals and whom police are likely to treat as suspects unless and until countervailing evidence surfaces (Hazel, J. W., Clayton, E. W., Malin, B. A., & Slobogin, C., 2018).

This higher productivity would be beneficial for security as well as reducing the chance of misidentifying suspects because of the inconsistencies caused by the present process of multi database searching. A universal database has the potential to eliminate the need for and use of "shadow" databases. Shadow databases are created by authorities and are compiled of

not only of people arrested for any crime but also of people who are merely stopped on suspicion of having committed a crime without being arrested (the so-called "stop-and-spit" and "swab-and-go" practices). As a result, arrest-based DNA databases contain a huge proportion of the young nonwhite male population and a much smaller representation of other groups (Hazel, J. W., Clayton, E. W., Malin, B. A., & Slobogin, C., 2018).

The universal database could be a way to combat discriminatory problems in theory, but still remaining is the issue of privacy.

Hazel and the other authors of this article believe that a universal database could still be private, given proper regulations or legislation surround it. Hazel et al., notes that this legislation would have to include statements saying that

genetic data [should] not only be uncoupled from any personal identifiers within the system, as it is in CODIS, but also establish a more robust "unmasking" process that limits law enforcement access to any personal information until an association has been made and confirmed (Hazel, J. W., Clayton, E. W., Malin, B. A., & Slobogin, C., 2018).

This "unmasking process" both protects the private information of the DNA but also protects suspects from being found based on bias – only a match or "association" would have its identifying information revealed. The authors also propose that the database must not be used without a proper warrant and that the database may only be used by authorities in serious crimes such as murder or missing persons investigations. The authors then turn to the question of ownership, they recommend that

universal database legislation should also require that the DNA database be housed in an independent agency… [And] the law should require that the physical samples analyzed to create the database be destroyed after obtaining the relevant genetic information, to mitigate the risk that the sample will be subjected to further analysis or used for purposes other than populating the database (Hazel, J. W., Clayton, E. W., Malin, B. A., & Slobogin, C., 2018).

With these different views of the future that genetic genealogy is either a problem starting to snowball or that it should be embraced and compiled into a universal database for society's benefit, information managers have their work cut out for them. Here's why.

What Does it all Mean for Information Managers?

The advances of DNA testing from forensics to genetic genealogy and its accompanying databases have started to create an industry that information managers must be involved in. This involvement ranges from being the consulting genealogist such as CeCe Moore consulting with police departments to map family trees, to information managers helping navigate the rising concerns with regulation and privacy of information with these databases. The concerns and predictions for the future that are explored in the above section pose implications for the information management field. These implications are broader than creating new jobs or information rolls within an industry.

With the prediction that genetic information and its storing method needs to be regulated, the current discussions that information professionals are having explore questions like; what is private information anymore? Do we even have privacy in the age of technology and big data? In the article "The power of forensic DNA data bases in solving crime cases" the authors examine different cases of crime solving via DNA databases to weigh in on the conversation around regulation. The authors conclude "some safeguards are implemented at the national or regional level, but there is a lack of global standards and a need for more societal engagement and debate" (Jakovski, Z., Ajanovska, R. J., Stankov, A., Poposka, V., Bitoljanu, N., & Belakaposka, V., 2017). The need for regulations are demonstrated by genetic genealogy database companies that use participant's DNA in applications that the participants did not explicitly sign up for. However, the benefits of these databases are substantial especially, as this paper has demonstrated, in regards to criminal investigations and justice for victims of crimes previously believed to be unsolvable.

With databases growing and with their potential to become one of the main ways that investigators solve crimes, it raises the question of how such data must be managed in a way that can be useful.

As earlier noted using the article "Is it time for a universal database?" there are discussions beginning to happen regarding a universal genetic database. Previously, I explored the benefits and some concerns with a universal database. The authors of this article concluded that a universal database would help investigations and society because crime solving and other functions of the databases would become less discriminatory, stating that "putting the idea of a universal forensic database on the table would spur a long overdue debate about the deficiencies of the current system and, more broadly, our societal commitment to privacy, fairness, and equal protection under the law" (Hazel, J. W., Clayton, E. W., Malin, B. A., & Slobogin, C., 2018). For information managers this could raise the question of one universal database, why not more? It could lead to universal databases for other types of identifying information, or set a precedent for how private information should be organized, controlled, and used in such mass quantities.

Conclusion

Genetic genealogy as an investigative tool is invaluable considering every year in the United States alone there are 5000 cases that go cold or remain unsolved (Holes & Jensen, 2019). Genetic genealogy practices are able to help reduce the staggering amount of unsolved cases, aid in the investigations of major crimes, and help identify "Jane/John Doe" murder victims. However, the way genetic searches are conducted can be problematic because of how the genetic information is managed and stored. This management and storage is what forces investigators to perform some "gray area" searches. These searches will become more frequent

given the increasing value of genetic data to law enforcement, the low level of justification required for a subpoena, and the tremendous amount of effort that can be associated with long-range familial searching by using a resource such as GEDmatch, which might generate dozens or hundreds of possible leads in a given case (Hazel, J. W., Clayton, E. W., Malin, B. A., & Slobogin, C., 2018).

As this potential pool of genetic information grows, law enforcement will continue to access and search the data.

Under the current system the databases that law enforcement have initial access to are comprised of data from convicted criminals and other DNA information used during investigations, or "shadow" profiles. These databases and profiles are inherently discriminatory because of the nature of police profiling, consisting of a mostly non-white constituency. When police decide to outside the internal database system other issues can arise regarding whose genetic information they actually access. This is because when police get a degree of matches, the matches are often comprised of innocent relatives as seen in the John D. Miller case. Overall, the biggest issue with the use of genetic genealogy in police work comes from inconsistencies in information management, and regulation, causing privacy concerns of the public as a result of these inconsistencies.

You may have caught onto the direction in which this is heading; the concept previously discussed of a universal database. Consider that Ancestry, only one of the companies that will store genetic information in its databases, has sold over six million DNA tests in Canada alone (Ancestry, 2018). 23andMe, another company, has collected one billion phenotype data points and has over two million genotyped customers (23andMe, 2017). Yet another company GEDmatch, has seen an increase after the capture of DeAngelo in April 2018 from 1500 uploads per day to 5000 uploads (Wikipedia, 2018). This does not include the amount of genetic information stored in other databases such as in law enforcement, medicine, scientific research, and similar operations. As information managers the unique thing about these companies is the public choosing to contribute their genetic information. The public is voluntarily sending their genetic information to these companies, contributing to their genetic collection and databases. Does this mean that ancestry and the use of genetic information to solve crimes is something that the public wants? Do we need to figure out a way to give them this service safely and in a non-discriminate way? Exploring this trend it seems so. The public is interested in these services and is increasingly contributing more genetic information to these databases. However, as Andrea Roth a professor of law at the University of California recognizes, "innocent people looking for long-lost family may be surprised to find that putting their DNA on a public website opens them and their relatives to police scrutiny" (Roth quoted by Saey, 2018).

It seems that if the universal database functioned as described by Hazel e al., it would be a way to provide less discrimination in the system, and a more efficient crime-solving tool. However, for all the predictions into this concept there hasn't been much commentary on the "how." It seems that we should embrace the use of genetic genealogy in criminal investigations based on the success stories so far. This trend should be kept on the minds of information managers as we try to navigate the landscape of genetic databases moving forward. Particularly information managers need to consider how to implement regulation and policy around genetic information willingly provided by the public. Even if the information is willingly provided, information managers should be involved in finding ways to keep that information safe as well as useful; as Roth notes, "genetic genealogy searches put too many people under police scrutiny and should be regulated like law enforcement databases" (Roth quoted by Saey, 2018). Genetic databases are versatile and useful over multiple fields, and could be more efficient as one total database. If this continues to be a trend that the public desires and actively participates in, it is within the information managers' role to find a way to facilitate this activity in a safe and organized method.

References

Ancestry. (2018). About ancestry. Ca. Retrieved from https://www.ancestry.ca/cs/legal/Overview

23andMe. (2017). About us. Retrieved from https://mediacenter.23andme.com/company/about-us/

Butler, J. M. (2015). The future of forensic DNA analysis. Philosophical Transactions of the Royal Society B: Biological Sciences, 370(1674). Retrieved from https://doi.org/10.1098/rstb.2014.0252

Crenson, M. (1997, March 2). Serial rapist's conviction was first to involve DNA. Los Angeles Times. Retrieved from http://articles.latimes.com/1997-03-02/local/me-33996_1_serial-rapist

Crist, C. (2018, June 1). Experts outline ethics issues with use of genealogy DNA to solve... Reuters. Retrieved from https://www.reuters.com/article/us-health-ethics-genealogy-dna-idUSKCN1IX5O6

DNA Diagnostics Center. (2018). History of dna testing. Retrieved from https://dnacenter.com/history-dna-testing/

Friedman, A. (1999). Forensic DNA profiling in the 21st century. Retrieved from https://journals.sagepub.com/doi/pdf/10.1177/0306624X99432004

Genetic genealogy - parabon® snapshot® dna analysis service. (2018). Retrieved from https://snapshot.parabon-nanolabs.com/genealogy

Hazel, J. W., Clayton, E. W., Malin, B. A., & Slobogin, C. (2018). Is it time for a universal genetic forensic database? Science, 362(6417), 898–900. Retrieved from https://doi.org/10.1126/science.aav5475

Holes, P., Jensen B. (2019). The murder squad: Terry Rasmussen. Exactly Right Network, Episode 2. Retrieved from www.themurdersquad.com

Innocent Staff. (2018, July 5). Death row exoneree kirk bloodsworth marks 25 years of freedom. Retrieved from Innocence Project website https://www.innocenceproject.org/kirk-bloodsworth-25years/

Levanson E. and Watts A. (2018, July 7). Child-killer taunted investigators for 30 years with disturbing notes. DNA ends the mystery of who did it, police say. Retrieved from https://www.cnn.com/2018/07/16/us/cold-case-april-tinsley-dna-trnd/index.html

Moran, K. S. (2018). Damned by DNA — Balancing personal privacy with public safety. Forensic Science International, 292, e3–e4. Retrieved from https://doi.org/10.1016/j.forsciint.2018.09.011

Murphy, E. (2018). Law and policy oversight of familial searches in recreational genealogy databases. Forensic Science International, 292, e5–e9. Retrieved from https://doi.org/10.1016/j.forsciint.2018.08.027

NYT Staff. (1988, February 6). Rapist convicted on dna match. The New York Times. Retrieved from https://www.nytimes.com/1988/02/06/us/rapist-convicted-on-dna-match.html

Parabon Nanolabs (2018). Engineering DNA for next-generation therapeutics and forensics. Retrieved from https://parabon-nanolabs.com/

Phillips, T. (2018). RFLP and how DNA analysis decodes crime scene evidence. Retrieved from https://www.thebalance.com/rflp-definition-and-dna-analysis-applications-375574

Ram, N., Guerrini, C. J., & McGuire, A. L. (2018). Genealogy databases and the future of criminal investigation. Science, 360(6393), 1078–1079. Retrieved from https://doi.org/10.1126/science.aau1083

Saey, T. H. (2018). Crime solvers embraced genetic genealogy. Science News, 194(12), 22–22.

Snow, K., & Schuppe, J. (2018, July 18). “This is just the beginning”: How a small forensics company is cracking cold cases. Retrieved from https://www.nbcnews.com/news/us-news/just-beginning-using-dna-genealogy-crack-years-old-cold-cases-n892126

Zhang, S. (2018, May 19). The coming wave of murders solved by genealogy. Retrieved from https://www.theatlantic.com/science/archive/2018/05/the-coming-wave-of-murders-solved-by-genealogy/560750/