This document sets forth background materials on the scientific research supporting examinations as conducted by the forensic laboratories at the Department of Justice. It also includes a discussion of significant policy matters. This document is provided to assist a public review and comment process of the related Proposed Uniform Language for Testimony and Reports (posted separately). It is not intended to, does not, and may not be relied upon to create any rights, substantive or procedural, enforceable by law by any party in any matter, civil or criminal, nor does it place any limitation on otherwise lawful investigative and litigative prerogatives of the Department.

SUPPORTING DOCUMENTATION FOR DEPARTMENT OF JUSTICE PROPOSED UNIFORM LANGUAGE FOR TESTIMONY AND REPORTS FOR THE FORENSIC LATENT PRINT DISCIPLINE

Background

Friction ridge skin is found on the palmar surfaces of the hands and the soles of the feet. It is a specialized type of skin consisting of ridges and furrows that aid in the grasping of objects. During fetal development, friction ridges form in a highly complex and unique arrangement and persist in that same arrangement throughout an individual's life, barring permanent injury and scarring.[1] An impression of the friction ridge arrangement may be left behind when a hand or foot comes into contact with an object. When this impression is deliberately recorded in a controlled environment, usually with ink and paper or a digital scanner, it is commonly referred to as a known print. Conversely, the term 'latent print' is used to describe when the impression is unintentionally transferred in a substance such as sweat or grease. Latent prints are typically fragmentary in nature and may require forensic light sources, chemicals, or powders to visualize them. The source of a latent print is unknown but a latent print may be compared to known prints in an attempt to determine the source of the impression.

Theory of Latent Print Examination

The use of latent prints as a means of identification rests on the premises that friction ridge skin forms in a unique and persistent arrangement. Numerous biologists, embryologists, and geneticists have studied the structure and development of the skin.[2] These studies demonstrate that once the friction ridge skin has been formed, the underlying skin structures and physiology of cells located in various layers of the skin

[1] ----. (2011). National Institute of Justice. The Fingerprint Sourcebook. (www.nij.gov/pubs-sum/225320.htm) Chap. 2-3; Wertheim, K., & Maceo, A. (2002). The Critical Stage of Friction Ridge and Pattern Formation. Journal of Forensic Identification 52(1): 35-85.

[2] ----. (2011). SWGFAST Response to The Research, Development, Testing & Evaluation Inter-Agency Working Group of the National Science and Technology Council, Committee on Science, Subcommittee on Forensic Science (www.swgfast.org).

work to maintain the established friction ridge arrangement.[3] The results of these studies demonstrate that the friction ridges remain in the same arrangement throughout an individual's life (barring permanent injury and scarring) until after death when decomposition begins to impact the arrangement.[4]

Further research reveals that friction ridge skin is formed due to a complex set of genetic and environmental factors *in utero*.[5] The results of these studies support the premise that friction ridge skin forms in a unique arrangement. This unique arrangement forms in patterns, which are different from person to person and finger to finger. Scientific testing of this premise has demonstrated that even identical twins, who share the same genetic information, have different fingerprints.[6] Examiner observation and empirical data from automated fingerprint databases further support this premise in that no two individuals have ever been found to have the same fingerprint.[7]

When the persistent and unique friction ridge information is transferred, the resulting impression may be compared and potentially provide a means of identification.

Latent Print Comparison Process

There are different methodologies and processes for conducting a latent print examination. The Department shares information regarding some appropriate processes below. The Department does not suggest that the processes outlined here are the only valid or appropriate processes.

Latent print comparisons are guided by the Analysis, Comparison, and Evaluation (ACE[8]) process, which includes both a qualitative and quantitative assessment of the

[3] Wilder, H. H.; Wentworth, B. *Personal Identification;* The Gorham Press: Boston, 1918; Chacko, S; Vaidya, M. The Dermal Papillae and Ridge Pat-terns in Human Volar Skin. *Acta Anatomica (Basel)* 1968, *70* (1), 99–108.

[4] Herschel, W. J. *The Origin of Finger-Printing;* Oxford University Press: London, 1916; Faulds, H. On the Skin—Furrows of the Hand. *Nature* 1880, *22*, 605; Galton, F. *Finger Prints;* Dover: Mineola, NY, 2005.

[5] Babler, W.J. (1991). Embryologic Development of Epidermal Ridges and Their Configurations. In C.C. Plato, R.M. Garruto, & B.A. Schaumann (Eds.), Dermatoglyphics: Science in Transition, Birth Defects: Original Article Series 27(2), pp. 95-112, Wiley-Liss, New York, NY; Cummins, H.; Midlo, C. Finger Prints, Palms and Soles: An Introduction to Dermatoglyphics; Dover: New York, 1943; Hale, A. Morphogenesis of Volar Skin in the Human Fetus. Am. J. Anat. 1952, 91 (1), 147–173.

[6] Lin, C. H. et al. (1982). Fingerprint Comparison I: Similarity of Fingerprints. *Journal of Forensic Sciences.* 27(2): 290-304; Liu, Y. and Srihari, S.N. (2009). A Computational Discriminability Analysis on Twin Fingerprints. *Computational Forensics*, 43-54, http://dx.doi.org/10.1007/978-3-642-03521-0_5; Srihari, S. N.; Srinivasan, H.; Fang, G. (2008). Discriminability of Fingerprints of Twins. Journal of Forensic Identification 58(1): 109-127.

[7] ----. (2011). National Institute of Justice. The Fingerprint Sourcebook. (www.nij.gov/pubs-sum/225320.htm) Chap. 6.

[8] ACE is commonly known as ACE-V (verification). Verification is the independent application of ACE to a friction ridge impression by another qualified examiner.

friction ridge impressions.[9] The steps of ACE are applied to friction ridge impressions as appropriate and are documented in a linear-type fashion with the examiner first conducting an analysis.

Analysis is the primary examination of a friction ridge impression by a qualified examiner, in which the quantity and quality of the features detected in the print are assessed.

Quantity of features refers to the amount of information present in the impression. These features can be broken down into three levels of detail. Level 1 detail refers to the overall ridge flow, including pattern type of impressions from the distal joint of the finger. There are three general pattern types: arch, loop, and whorl (Fig. 1[10]).

(a) (b) (c)

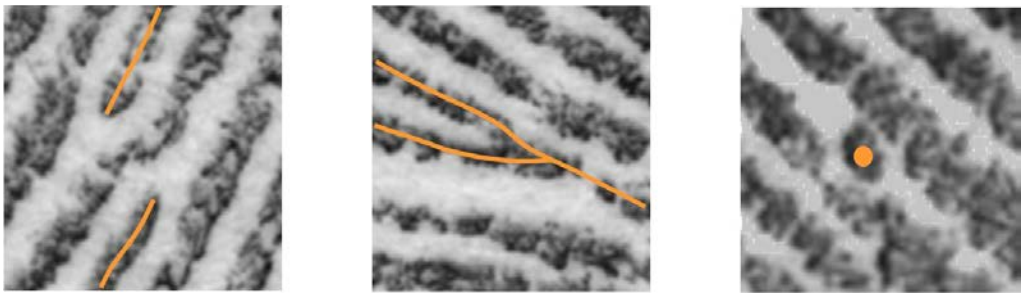
Figure 1: The general overall friction ridge pattern types. (a) arch, (b) loop, and (c) whorl. These general pattern types, alone, do not contain enough information to effect an identification. However, they may be used for exclusion purposes.

Level 2 detail refers to individual friction ridge paths and ridge events. There are three standard ridge events that may occur: ending ridge, dividing ridge, and dot (Fig. 2). Although there are only three characteristics, the multitude of possible combinations of these ridge events adds to the rarity of the print.[11]

[9] Ashbaugh, D.R. Quantitative-Qualitative Friction Ridge Analysis CRC Press, Boca Raton, Florida (1999); FBI Laboratory Latent Print Operations Manual Examining Friction Ridge Prints, Issue Date: 5/24/11, Revision 5; SWGFAST Standards for Examining Friction Ridge Impressions and Resulting Conclusions (Latent/Tenprint), Ver. 2.0, Issue Date 03/13/13 (http://www.swgfast.org/Documents.html); Latent Print Examination and Human Factors: Improving the Practice through a Systems Approach (http://www.nist.gov/oles/upload/latent.pdf).

[10] U.S. Department of Justice, Federal Bureau of Investigation. The Science of Fingerprints. U.S. Government Printing Office, Washington, DC. 1984.

[11] Gutierrez, E.; Galera, V.; Martinez, J. M.; and Alonso, C. (2007). Biological Variability of the Minutiae in the Fingerprints of a Sample of the Spanish Population. Forensic Science International 172:98-105; Gutierrez-Redomero, E.; Alonso-Rodriguez, C.; Hernandez-Hurtado, L. E.; and Rodriguez-Villalba, J. L. (2011). Distribution of the Minutiae in the Fingerprints of a Sample of the Spanish Population. Forensic Science International 208:79-90.



(a) (b) (c)

Figure 2: Ridge events are represented by three basic minutiae types. (a) ending ridge, (b) dividing ridge, and (c) dot. Ending ridges are ridges that flow and then stop with the adjacent ridges converging to maintain equal spacing between the surrounding ridges. Dividing ridges are ridges that flow then divide into two ridges. A dot is a ridge that is as long as it is wide. These minutiae types occur at different frequencies and may be more populous in certain areas of the print. These basic minutiae types may intermix to create the formation of additional compound ridge characteristics.

Level 3 detail refers to ridge structures, such as edge shapes and pores (Fig. 3). Since the appearance of level 3 detail is not always transferred reliably, it is only used to supplement Level 1 and Level 2 information.[12]

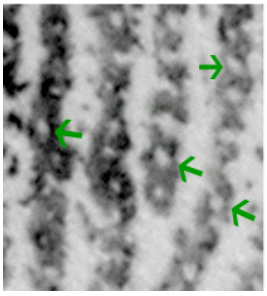


Figure 3: Level 3 detail refers to the ridge structure and consists of edge shapes and pore locations. The green arrows indicate the pore locations on the friction ridge.

An examiner will not only assess the type of feature, but also the location, the spatial relationship between that characteristic and other characteristics, and the direction of ridge flow within the print.

Quality and appearance of the impression may be affected by various factors when a print is transferred. An examiner needs to consider these factors when determining the allowance of variation in the appearance of friction ridge features. These factors include: transfer conditions (e.g. deposition pressure (Fig. 4)), transfer medium (e.g. blood),

[12] Anthonioz, A.; Egli, N.; Champod, C.; Neumann, C.; Puch-Solis, R.; and Bromage-Griffiths, A. (2011). Investigation of the Reproducibility of Third-Level Characteristics. *Journal of Forensic Identification* 61(2): 171-192.

detection method (e.g. superglue), substrate (e.g. porous), environmental factors (e.g. weather), and preservation method (e.g. lift).[13]

An impression is deemed to be of value when the examiner determines that sufficient reliable information is present, such that, when compared to another print from the corresponding area of the same individual, an identification decision can be reached.[14] In other words, an examiner will determine an impression to be sufficient when their assessment of the quality and quantity of information contains enough rarity that the examiner would not expect to see that same amount of information repeated in another source.[15] A thorough analysis is conducted and documented on latent friction ridge impressions prior to conducting comparisons to known prints.[16] This is intended to reduce the effect of bias on the examiner in the comparison phase.

The potential for bias exists with any cognitive process to include latent print examinations as well as other professions that employ human decision making.[17] In the latent print discipline, an examiner may experience a form of bias in the comparison process known as circular reasoning. Circular reasoning is a cognitive bias in which the examiner is influenced by the information contained within the known print and allows that information to affect the assessment of the latent print. As a result, agencies within the Department adapted existing quality assurance measures to include documenting information in the latent print prior to analyzing the known print to mitigate the risk of having bias impact the examination process.

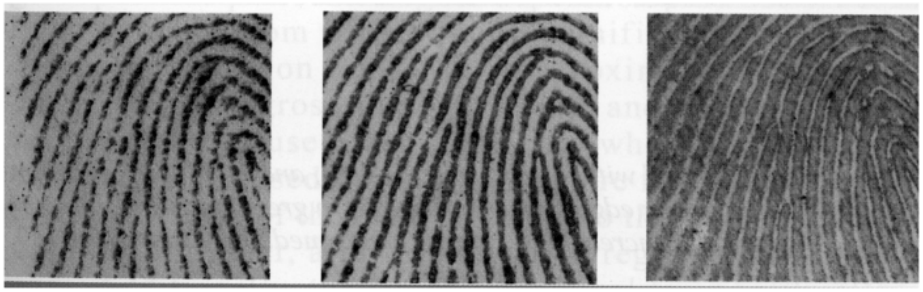
[13] SWGFAST. Standards for Examining Friction Ridge Impressions and Resulting Conclusions - Latent/Tenprint. Scientific Working Group on Friction Ridge Analysis, Study and Technology. [Online] November 24, 2011. http://www.swgfast.org/Documents.html; Qualitative Assessment of Skin Deformation: A Pilot Study. Maceo, A. 4, 2009, Journal of Forensic Identification, Vol. 59, pp. 390-440.

[14] The assessment of the information in an impression contains much more than number of characteristics alone. Focusing only on the number of characteristics in the impression would cause an examiner to ignore additional information such as the clarity of the impression, level one detail, most of level two detail, and level three detail. Instead the examiner will assess all the information in the impression. Therefore, there is no minimum number of points needed for an examiner to determine an impression to be sufficient.

[15] Champod, C. and P. Margot (1997). Analysis of Minutiæ Occurrences in Fingerprints – The Search for Non- Combined Minutiæ. *Current topics in Forensic Science – Proceedings of the 14th Meeting of the International Association of Forensic Sciences*. T. Takatori and A. Takasu, Shunderson Communications, Ottawa. 1**:** 55-58; Stoney, D. A. and J. I. Thornton (1986). "A Critical Analysis of Quantitative Fingerprint Individuality Models." *Journal of Forensic Sciences* 31(4): 1187-1216.

[16] A forensic laboratory's standard operating procedures require documentation of each phase of the ACE process. As a result, the examiner is required to separately document any data relied upon that differs from the initial analysis. Therefore, the documentation increases the transparency of the information the examiner used to come to a conclusion.

[17] Dror, I. E., Kosslyn, S. M., & Waag, W. (1993). Visual-spatial abilities of pilots. *Journal of Applied Psychology, 78 (5),* 763-773.



(a) (b) (c)

Figure 4: Deposition pressure affects the appearance of a friction ridge impression. (a) low, (b) medium, and (c) high deposition pressure. Due to the elasticity of the skin, an increased deposition pressure will increase the surface area contact of the finger with the substrate and widen the friction ridges while narrowing the furrows. As a result, the ridge edge shapes will be altered and the clarity will be reduced in the case of extreme pressure.[18]

Comparison is the direct side-by-side observation of friction ridge prints of value to determine whether the information observed during Analysis is in disagreement or agreement between a latent and known impression. When determining if features correspond, an examiner considers variation in the appearance of the friction ridge prints that may be attributed to factors such as pressure and movement.

Evaluation is the formation of a conclusion based on the examiner's observations, assessments, and documentation generated during the Analysis and Comparison steps. The observation and assessment refers to the examiner's interpretation of the features found to be either in agreement or disagreement between two prints in order to come to a conclusion. The conclusion is supported by the examiner's ability to assess the frequency of features and rarity of configurations present within the print as described above in analysis. Three conclusions that may be reached are: *identification*, *exclusion*, or *inconclusive*.

Policy Considerations

A. Madrid Error- 2004

On March 11, 2004, terrorists detonated bombs on several commuter trains in Madrid, Spain killing nearly 200 and injuring more than 1,400. The Spanish National Police (SNP) recovered latent fingerprints from detonators tied to the attacks and forwarded them to the Federal Bureau of Investigation (FBI) for analysis. The FBI Latent Print Unit (FBI LPU) received two latent prints from the SNP for automated searches to be conducted. As a result of those searches, the FBI LPU identified and verified one of the latent prints to a U.S. citizen, this print was later determined to be an erroneous identification. The SNP was not satisfied with the FBI's results and identified another suspect.

[18] Qualitative Assessment of Skin Deformation: A Pilot Study. Maceo, A. 4, 2009, Journal of Forensic Identification, Vol. 59, pp. 390-440.

Upon learning of this development, the FBI LPU requested additional information pertaining to the latent prints from the SNP. Ultimately, on July 16, 2004, the FBI LPU determined they had initially made an incorrect identification.

As a result of the FBI LPU's erroneous association in the Madrid case, the FBI Laboratory, on its own initiative, convened review teams to assess various aspects of the FBI LPU.[19] In addition to conducting a root cause analysis, the review panels evaluated areas such as the underlying science, documentation practices, and training program. As a result of these reviews it was determined that the false positive was a result of circular reasoning: the examiners were biased by the known print which had an unusual amount of similarity to the latent print and relied too heavily on level 3 information (the size and shapes of pores and ridges).

The U.S. Department of Justice Office of the Inspector General (OIG) also conducted an investigation into, among other things, the causes of the misidentification, and the FBI Laboratory's response to the error. The OIG issued a written report in January 2006 which included 18 recommendations.[20] The OIG issued a follow-up report in June 2011 noting that "17 of 18 recommendations can be closed without further action by the FBI Laboratory." The report further noted that the remaining recommendation, regarding a review of capital cases, was resolved in that FBI LPU implemented the recommendation. This capital case review is ongoing."[21]

As a result of the internal and external recommendations, the FBI LPU's Standard Operating Procedures now provide a detailed description of each phase of the ACE process and require documentation of the analysis of the latent print before conducting an analysis of the known print. Furthermore, during comparison and evaluation, the examiner is required to document any data relied upon that differs from the initial analysis. Verifiers must also document their ACE process. These steps are also in line with the standards published by Scientific Working Group on Friction Ridge Analysis, Study, and Technology (SWGFAST).

The FBI LPU's Standard Operating Procedures also now mandate an examiner to document the level 3 information if it is heavily relied upon to reach a conclusion. All available known prints on file must be evaluated to determine if the level 3 information was reliably and consistently reproduced. During training, examiners are taught that

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[19] There were two separate parts of this internal review. First, it brought a panel of outside fingerprint experts to the Laboratory for 2 days in June 2004 and then the FBI formed eight internal review teams.

[20] (2006). Office of the Inspector General. A Review of the FBI's Handling of the Brandon Mayfield Case. Department of Justice: Washington, D.C. (http://www.justice.gov/oig/special/s0606/final.pdf)

[21] (2011). Office of the Inspector General. A Review of the FBI's Progress in Responding to the Recommendations in the Office of the Inspector General Report on the Fingerprint Misidentification in the Brandon Mayfield Case. Department of Justice: Washington, D.C. (http://www.justice.gov/oig/special/s1105.pdf). The FBI LPU reports the status of the capital case review on a quarterly basis.

level 3 is not always transferred reliably and therefore should only be used to supplement the level 1 (overall pattern shape) and level 2 (ridge paths) information.

An additional quality assurance measure implemented in the aftermath of the Madrid error was Blind Verification, which is the independent application of ACE to a friction ridge print by another qualified examiner with limited awareness of the details of the case and no knowledge of the conclusion of the primary examiner.[22]

B. 2009 National Academy of Sciences Report

In 2006, Congress authorized the National Academy of Sciences (NAS) to conduct a study on forensic science which culminated in a 2009 report.[23] While the NAS committee determined that "because of the amount of detail available in friction ridges, it seems plausible that a careful comparison of two impressions can accurately discern whether or not they had a common source," the committee raised several criticisms pertaining to the practice of latent prints.[24]

One such criticism pertains to the subjectivity of the examination process. The NAS noted that "the ACE-V method does not specify particular measurements or a standard test protocol, and examiners must make subjective assessments throughout…As a result, the outcome of a friction ridge analysis is not necessarily repeatable from examiner to examiner."[25] There was limited published research available regarding the accuracy and reliability of examiner decisions in February 2009 when the NAS committee released its report; however, there have been several significant studies published since that time (see Published Research Post NAS Report section below for more detailed information regarding this research).

Another concern identified in the NAS Report involved documentation of the latent print examination process. The committee explained,

> Better documentation is needed of each step in the ACE-V process or its equivalent. At the very least, sufficient documentation is needed to reconstruct the analysis, if necessary. By documenting the relevant information gathered during the analysis, evaluation, and comparison of latent prints and the basis for the conclusion (identification, exclusion, or inconclusive), the examiner will create a transparent record of the method and thereby provide the courts with additional information on which to assess the reliability of the method for a specific case. Currently, there is no requirement for examiners to document which features within a latent

[22] FBI Latent Print Unit Quality Assurance Manual Blind Verification, Issue Date: 8/7/13, Revision 2.

[23] ----. (2009). National Research Council. Strengthening Forensic Science in the United States: A Path Forward (Summary and Friction Ridge Analysis section from Chapter 5). National Academy Press: Washington, D.C. (http://www.nap.edu/catalog/12589.html).

[24] NAS Chap. 5 pg. 142.

[25] NAS Chap. 5 pg. 139.

print support their reasoning and conclusions.[26]

While there is no enforceable standard for documentation in the United States, the Scientific Working Group on Friction Ridge Analysis, Study, and Technology (SWGFAST) has produced a standard for the documentation of ACE-V.[27] Similarly, agencies within the Department have specific requirements for the information that must be documented throughout the latent print examination process. The examination records must be sufficient not only to support the examiner's decisions, but also for another qualified examiner to evaluate what was done and interpret the data.[28]

Another "criticism of the latent print community is that the examiners can too easily explain a "difference" as an "acceptable distortion" in order to make an identification."[29] Recognizing the potential for error associated with this type of bias, agencies within the Department have revised their quality management documents and standards to clarify that when reaching an identification decision,

> an examiner must be confident that any apparent difference between two prints is due to distortion, and not an actual difference in friction ridge detail. This level of confidence must be consistent with the degree of confidence an examiner must have in order to reach an identification decision.

Similarly, when a complex examination results in an identification, "examiners must document any explanation for differences in level one or two detail caused by apparent distortion and identify supporting data for their explanation in the case record."[30]

The NAS committee went on to state "more research is needed regarding the discriminating value of the various ridge formations and clusters of ridge formations. This would provide examiners with a solid basis for the intuitive knowledge they have gained through experience and provide an excellent training tool. It also would lead to a good framework for future statistical models and provide the courts with additional information to consider when evaluating the reliability of the science."[31] While a statistical model has not yet been generally accepted for use in casework, research in this area continues and more advanced models have been developed.[32]

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[26] NAS Chap. 5 pg. 143.

[27] Standard for the Documentation of Analysis, Comparison, Evaluation, and Verification (ACE-V) (Latent).

[28] *See, e.g.,* FBI Laboratory Latent Print Operations Manual Examining Friction Ridge Prints, Issue Date: 5/24/11, Revision 5.

[29] NAS Chap. 4 pg. 145.

[30] *See, e.g.,* FBI Laboratory Latent Print Operations Manual Examining Friction Ridge Prints, Issue Date: 5/24/11, Revision 5.

[31] NAS Chap. 5 pg. 144.

[32] Neumann, C. et al. (2012). Quantifying the weight of evidence from a forensic fingerprint comparison: a new paradigm. *Journal of the Royal Statistical Society* 175, Part 2, pp. 371-415; Neumann, C.; Champod,

C. Published Research Post-NAS Report

The following studies represent some of the studies published after the NAS report was disseminated.

- Langenburg (2009) – In March 2009, the results of a method performance study were published. In this study, six fingerprint analysts participated in a series of 60 ACE and ACE-V trials. According to the study, "the results of the ACE testing, where each analyst received the same set of 60 fingerprint comparisons, showed 100% accuracy for all trials where an opinion of identification was reported" and 86% accuracy for those trials where an exclusion was reported. In the second part of the study, the researchers purposely provided the verifiers with nine false positives and six false negatives. The verifiers caught all nine false identifications, but none of the six false exclusions, presented to them.[33]

- Ulery (2011) – In May 2011, the results from a large-scale study testing examiners' accuracy were published. This study provides support for the principle that a qualified latent print examiner is capable of accurately identifying a latent print to a known print. One of the objectives of this study was to determine the frequency of false positive and false negative errors under the test conditions (difficult fingerprint comparisons in a computer-based test corresponding to one stage in Automated Fingerprint Identification System (AFIS) casework). In the study, 169 latent print examiners were each presented with approximately 100 image pairs resulting in 17,121 total decisions. The Positive Predictive Value was calculated to be 99.8%; meaning, when examiners reached an identification decision, they were right 99.8% of the time. For prints determined to be of value for identification, the Negative Predictive Value was calculated to be 88.9%; meaning, when examiners reached an exclusion decision, they were right 88.9% of the time. In the test, a total of six false positives occurred, out of 4,083 opportunities, for a False Positive Rate of 0.1%. No two examiners made the same false identification suggesting that the false identifications would have been caught if they had undergone blind verification. False negatives occurred at a higher rate than false positives. Out of 5,969 opportunities, 450 false negatives occurred, for a False Negative Rate of 7.5%. Additionally, 85% of the participating examiners had at least one false negative error.[34]

C.; Yoo, M.; Genessay, T.; and Langenburg, G. (2103). Improving the Understanding and the Reliability of the Concept of "Sufficiency" in Friction Ridge Examination. NIJ Report (Award 2010-DN-BX-K267).

[33] Langenburg, G. (2009). A Performance Study of the ACE-V Process: A Pilot Study to Measure the Accuracy, Precision, Reproducibility, Repeatability, and Biasability of Conclusions Resulting from the ACE-V Process. *Journal of Forensic Identification* 59(2): 219-257.

[34] Ulery, B.T.; Hicklin, R.A.; Buscaglia, J.; and Roberts, M.A. (2011). Accuracy and Reliability of Forensic Latent Fingerprint Decisions. *Proceedings of the National Academy of Sciences* 108(19): 7733-7738, Appendices 1-26.

- Tangen (2011) – This study compared the performance between experts and novices. While not infallible, the qualified fingerprint experts were significantly more accurate than the novice group, particularly with the difficult "close non-match" comparisons. For this set of comparisons, the experts had a false positive rate of 0.68% (compared to 55.18% for the novices) and a false negative rate of 8% (compared to 25% for the novices). The results add support to the premise that trained, qualified examiners can produce largely accurate and reliable conclusions.[35]

- Ulery (2012) – In March 2012, the results of a study testing the repeatability and reproducibility of examiner decisions on latent prints were published. This study tested repeatability by retesting 72 examiners on comparisons of 25 image pairs after a seven-month interval. The authors noted that repeatability and reproducibility were lower when examiners assessed the comparison as "difficult" (as opposed to "easy" or "moderate"). In those instances when examiners had differing opinions, the authors noted that the variability mostly occurred on whether there was enough information to reach a decision (inconclusive) on the more difficult comparisons. It was far less common for two examiners to disagree on the conclusion itself (exclusion or identification).[36]

Statements Approved for FBI Latent Print Unit Examination Testimony and/or Laboratory Reports

A. Identification

The examiner may state or imply that an *identification* is the determination that two friction ridge impressions originated from the same source because there is sufficient quality and quantity of corresponding information such that the examiner would not expect to see that same arrangement of features repeated in another source. While an *identification* to the absolute exclusion of all others is not supported by research, an *identification* conclusion is supported by the biological premise that friction ridge skin is persistent and unique,[37] population studies that have assessed the frequency of features,[38] and statistical models, which have demonstrated that as more reliable features are found

[35] Tangen, J.M.; Thompson, M.B.; and McCarthy, D.J. (2011). Identifying Fingerprint Expertise. *Psychological Science* 22(8): 995-997.

[36] Ulery, B.T.; Hicklin, R.A.; Buscaglia, J.; and Roberts, M.A. (2012). Repeatability and Reproducibility of Decisions by Latent Fingerprint Examiners. *PLoS ONE* 7(3): e32800. doi:10.1371/journal.pone.0032800.

[37] ----. (2011). National Institute of Justice. The Fingerprint Sourcebook. (www.nij.gov/pubs-sum/225320.htm) Chap. 2-3; Wertheim, K., & Maceo, A. (2002). The Critical Stage of Friction Ridge and Pattern Formation. *Journal of Forensic Identification* 52(1): 35-85.

[38] Gutierrez, E.; Galera, V.; Martinez, J. M.; and Alonso, C. (2007). Biological Variability of the Minutiae in the Fingerprints of a Sample of the Spanish Population. *Forensic Science International* 172:98-105; Gutierrez-Redomero, E.; Alonso-Rodriguez, C.; Hernandez-Hurtado, L. E.; and Rodriguez-Villalba, J. L. (2011). Distribution of the Minutiae in the Fingerprints of a Sample of the Spanish Population. *Forensic Science International* 208:79-90.

in agreement, it becomes less likely to find that same arrangement of features in a print from another source.[39]

B. Inconclusive

An examiner may state or imply that an *inconclusive* result is the determination that there is insufficient quality and quantity of corresponding information between two impressions such that the examiner is unable to identify or exclude the impressions as coming from the same source. For example, if the print compared is from the tip or lower joint of a finger and the corresponding area is not fully captured on the available exemplar(s), or the corresponding area is unusable due to distortion, then an inconclusive decision would be reached.

Therefore, when an examiner does not have enough information available to reach an identification or exclusion conclusion, an inconclusive decision is reported.

C. Exclusion

An examiner may state or imply that an *exclusion* is the determination that two friction ridge impressions did not originate from the same source because there is sufficient quality and quantity of information in disagreement.[40] This opinion is supported by the biological premise that friction ridge skin is persistent and unique which would indicate that two impressions came from different sources if there are friction ridge details in one impression that do not exist in the corresponding area of another impression.

It is important to note that it is possible for an individual to handle an object and not leave latent prints. This is because of the many factors involved in the deposition and preservation of a friction ridge print. For example, gloves or dry hands may prevent the transfer of the friction ridge impression onto the item when handled. Other factors could include transfer conditions, detection method, substrate, environmental factors, and preservation method.[41] Therefore, excluding an individual as being the source of a print does not necessarily mean that the individual did not touch the item. Similarly, an object without latent prints detected on it could have been handled by multiple individuals.

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[39] Quantifying the weight of evidence from a forensic fingerprint comparison: a new paradigm. Neumann, C. et al. Part 2, 2012, *Journal of the Royal Statistical Society*, Vol. 175, pp. 371-415.

[40] Historically, the "One Discrepancy Rule" or "One Dissimilarity Doctrine" has been applied as the standard for exclusion. However, current practices require a sufficient amount of information to be in disagreement for an exclusion decision. In the presence of an overwhelming amount of information in agreement, a single discrepancy may not be enough to support exclusion decisions.

[41] SWGFAST. Standards for Examining Friction Ridge Impressions and Resulting Conclusions - Latent/Tenprint. Scientific Working Group on Friction Ridge Analysis, Study and Technology. [Online] November 24, 2011. http://www.swgfast.org/Documents.html; Qualitative Assessment of Skin Deformation: A Pilot Study. Maceo, A. 4, 2009, Journal of Forensic Identification, Vol. 59, pp. 390-440.

Statements Not Approved for FBI Latent Print Unit Examination Testimony and/or Laboratory Reports

A. Exclusion of All Others

The biological premise that friction ridge arrangements are unique and persistent and can be used for identification purposes has not changed. Examiners must explain this premise in a manner that is consistent with current research.

For over a century, latent print examiners operated under the premise that since friction ridge skin is both persistent and unique, when a sufficient amount of information is transferred onto an object in a latent impression, that resulting latent impression may be identified to a single source to the exclusion of all other sources. This notion was based upon empirical data that no two people have been found to have the same friction ridge arrangement, as well as statistical models assessing uniqueness. Previous statistical models, such as Galton's Model, made an inference that individuals can identify latent prints to the exclusion of all others.[42] As such, examiners testified to identifications to the level that research supported at that time.

With the introduction of more scientists in the field in the 1990s, research has advanced and statistical models have become more sophisticated. These advancements no longer support testimony stating to the exclusion of all others.[43] The development of statistical models are ongoing, focusing on assessing the rarity of features and the various configurations these features generate, to determine the likelihood that the same configuration of features *could* appear in another source.[44] Until these new statistical models are proven to be reliable and validated for use in casework, examiners must consider whether another area of friction ridge skin could have left a similar looking latent print, particularly in impressions that lack clarity or contain less quantity of information. Today, examiners must explain the definitions of their conclusions clearly so not to overstate or understate the weight of their conclusion.

Therefore, without the support of a robust statistical model to assess the likelihood that a similar configuration of features could appear in another source, it is inappropriate for an examiner to state or imply that an identification conclusion would absolutely exclude the possibility that another source could have left a similar looking latent print.

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[42] Galton, F. *Finger Prints;* MacMillan: New York, 1892, pgs. 110-111 stated: "that as the number of the human race is reckoned at about sixteen thousand millions, it is a smaller chance than 1 to 4 that the print of a single finger of any given person would be exactly like that of the same finger of any other member of the human race."

[43] SWGFAST Individualization/Identification Position Statement, Issue Date: 9/11/2012, Ver. 1.0 "The ability of a latent print examiner to individualize a single latent impression, with the implication that they have definitely excluded all other humans in the world, is not supported by research and was removed from SWGFAST's definition of individualization."

[44] Quantifying the weight of evidence from a forensic fingerprint comparison: a new paradigm. Neumann, C. et al. Part 2, 2012, *Journal of the Royal Statistical Society*, Vol. 175, pp. 371-415.

B. Absolute or Numerical Certainty

In the past, examiners expressed identification conclusions as absolute certainties. While their certainty of the conclusion was based on the examiner's confidence in the information observed, it has since been noted that such statements may have been interpreted to mean that it was impossible that another person may have left the impression or that an error could not have been made. The degree of similarity between two impressions must be accurately expressed within the limits of the fingerprint discipline. The *SWGFAST Guideline for the Articulation of the Decision-Making Process for the Individualization in Friction Ridge Examination* states that, "As the practices of forensic science and of friction ridge examination have evolved, it is now recognized that our conclusions are more appropriately expressed as a decision, rather than proof."[45] Studies are ongoing in an attempt to establish a statistical model to quantify an examiner's conclusion.[46] However, until this model is shown to be reliable and validated for casework, the examiner will not provide any number to express the certainty of a conclusion. Examiners testifying to their conclusions may express they are confident in their decision by focusing on the basis of the conclusion. The basis of the conclusion relies upon the examiner's utilization of sufficient facts and data to evaluate the similarities and differences between two impressions. Examiners document the analysis of the latent impression before conducting an analysis of the known impression. This documentation demonstrates the sufficient facts and data used by the examiner to reach their decision. Furthermore, during comparison and evaluation, the examiner is required to document any data relied upon that differs from the initial analysis, increasing the transparency of the information the examiner used to come to a conclusion.[47] The conclusions are the assessment of the features by the examiner, which emanate from their skills, knowledge, experience, education, and training. Therefore, examiners need to accurately describe their training and demonstrate how they applied all of their knowledge and experience in arriving at their conclusion. In addition, examiners should be knowledgeable with and able to explain published reliability studies, which also demonstrate that qualified examiners accurately assess the friction ridge detail to produce reliable conclusions.[48]

Without a reliable, validated statistical model, examiners lack the ability to quantify the certainty associated with a conclusion. Therefore, it is inappropriate for an examiner

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[45] SWGFAST Guideline for the Articulation of the Decision-Making Process for the Individualization in Friction Ridge Examination (Latent/Tenprint) Revised Draft for Comment.

[46] Neumann, C. et al. (2012). Quantifying the weight of evidence from a forensic fingerprint comparison: a new paradigm. *Journal of the Royal Statistical Society* 175, Part 2, pp. 371-415.

[47] *See, e.g.*, FBI Laboratory Latent Print Operations Manual Examining Friction Ridge Prints, Issue Date: 5/24/11, Revision 5.

[48] Langenburg, G.; Champod, C.; and Wertheim, P. (2009). Testing for Potential Contextual Bias Effects During the Verification Stage of the ACE-V Methodology When Conducting Fingerprint Comparisons. *Journal of Forensic Sciences* 54(3): 571-582; Ulery, B.T.; Hicklin, R.A.; Buscaglia, J.; and Roberts, M.A. (2011). Accuracy and Reliability of Forensic Latent Fingerprint Decisions. *Proceedings of the National Academy of Sciences* 108(19): 7733-7738, Appendices 1-26; Tangen, J.M.; Thompson, M.B.; and McCarthy, D.J. (2011). Identifying Fingerprint Expertise. *Psychological Science* 22(8): 995-997.

to state or imply a level of certainty in his/her conclusion that is absolute or numerically calculated.

C. Zero Error Rate

Historically, it was common practice for an examiner to testify that when the ACE-V methodology was correctly applied, it would always produce the correct conclusion. Thus any error that occurred would be human error and the resulting error rate of the methodology would be zero. This view was described by the Department of Justice in 1984 in the publication *The Science of Fingerprints*, where it states, "Of all the methods of identification, fingerprinting alone has proved to be both infallible and feasible."[49] This historical perspective stemmed from the attempt (now known to be inappropriate) to separate the methodology error from practitioner error.

Today, as a result of a better understanding of the limitations of the friction ridge science, the testimony on error rates has shifted. A 2012 National Institute of Standards and Technology (NIST) report, states, "A testifying expert should be familiar with the literature related to error rates. A testifying expert should be prepared to describe the steps taken in the examination process to reduce the risk of observational and judgmental error. The expert should not state that errors are inherently impossible or that a method inherently has a zero error rate."[50]

The literature related to error rates emphasizes the difficulty in calculating a meaningful error rate for both individual practitioners, as well as across the entire discipline.[51] Recent studies have demonstrated that while examiners reach accurate and reliable conclusions, the calculated error rates in those studies are specific to the testing conditions of the studies and may not include all the quality assurance measures of a laboratory. [52] Such quality assurance measures include steps that are taken in the examination process to reduce the risk of error.

Further, research has been unable to calculate a meaningful predictive rate of error for the entire discipline. Nonetheless, because of the possibility of practitioner error, it is no longer permissible to state that the comparison process has a zero error rate.

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[49] Federal Bureau of Investigation, *The Science of Fingerprints;* U.S. Government Printing Office, 1984, pg. iv.

[50] Latent Print Examination and Human Factors: Improving the Practice through a Systems Approach (http://www.nist.gov/oles/upload/latent.pdf).

[51] Budowle, B. et al (2009). A Perspective on Errors, Bias, and Interpretation in the Forensic Sciences and Direction for Continuing Advancement. *Journal of Forensic Sciences* 54(4): 798-809.

[52] Ulery, B.T.; Hicklin, R.A.; Buscaglia, J.; and Roberts, M.A. (2011). Accuracy and Reliability of Forensic Latent Fingerprint Decisions. *Proceedings of the National Academy of Sciences* 108(19): 7733-7738, Appendices 1-26; Tangen, J.M.; Thompson, M.B.; and McCarthy, D.J. (2011). Identifying Fingerprint Expertise. *Psychological Science* 22(8): 995-997.