Friction Ridge Analysis in Florida Sheriff's Offices and Crime Laboratories

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Abstract

A significant number of fingerprint Units in Florida sheriff's offices and crime laboratories have policies and procedures in place to ensure quality results. Policies consistent with accreditation and scientific working group standards address criticisms of friction ridge analysis made by legal scholar and recommendations made in reports by National Academy of Sciences and Expert Working Group of Human Factors in Latent Print Analysis are reviewed. Wide spread adoption of quality assurance standards and continued research and data collection is needed to further the recommendations in the reports.

Introduction

Fingerprint individualization is a well-established practice in forensics and accepted by the criminal justice system. US Supreme Court decisions and well-publicized errors have increased and intensified criticisms about the reliability of fingerprint individualization. A committee of the National Academy of Sciences (NAS) published the results of a three-year research study of forensic sciences in the United States. The NAS committee reported its conclusions to the United State Senate in 2009. NAS report recommendations specific to the fingerprint analysis (friction ridge analysis) as well as recommendations from a three-year committee assessment on human factors in friction ridge analysis are outlined. Changes in Federal Bureau of Investigations (FBI) Laboratory procedures and updates to the guidelines of the Scientific Working Group on Friction Ridge Analysis, Study and Technology (SWGFAST) have been made to improve analysis reliability. A survey of Florida law enforcement agencies and crime laboratories on accreditation, quality assurance practices, training, certification, and specific analytical procedures recommended by the industry research addressing reliability in friction ridge analysis was conducted. This survey assesses current practices utilized by agencies in Florida and their future needs.

Literature Review

Friction Ridge Analysis

Friction ridge formations on the skin of the hands and feet provide increased friction for gripping (Office of Inspector General [OIG], 2011). Numerous studies regarding the structure, permanence, and individuality of friction ridge skin have been conducted since 1904 (SWGFAST 2012a). A fingerprint is a reproduction of the pattern of friction ridge skin when oil or other substances is deposited onto a surface a finger contacts (OIG, 2011). Impressions of friction ridge skin patterns obtained from items at a crime scene can be compared to impressions of a known individual, known as an exemplar, to identify or individualize the source of the crime scene impression (Triplett, 2010). ACE-V, an acronym for Analysis, Comparison, Evaluation, and Verification, is the four-step process used in friction ridge individualization (SWGFAST, 2012i).

> Analysis – The assessment of an impression to determine suitability for comparison.
> Comparison – The observation of two or more impressions to determine the existence of discrepancies, dissimilarities, or similarities.
> Evaluation – an examiner assesses the value of the details observed during the analysis and the comparison steps and reaches a conclusion.
> Verification – The independent application of the ACE process as utilized by a subsequent examiner to either support or refute the conclusions of the original examiner (SWGFAST 2012i).

Factors considered in the ACE-V process include the process in which the impression is transferred to a surface, the surface material, impression development, pressure, distortion and orientation (Triplett, 2010). Friction ridge skin details are categorized into three levels. Level 1details include general morphology, ridge flow and pattern type. Individual ridge paths, ridge attributes known as minutiae, and associated events are defined as Level 2 details. The dimensions of ridge attributes including width, edge shape, and pores are Level 3 details (SWGFAST 2012i). These factors, in addition to the quality and quantity of details, are all considered in the ACE-V process (Triplett 2010). The examiner determines if an impression of friction ridge skin contains sufficient details in agreement with a fingerprint standard or exemplar to conclude that the impression and standards came from a common source (SWGFAST 2012i).

Criticisms and the NAS Report

Despite the body of research on the individuality and permanence of friction ridge skin, critics of friction ridge individualization characterize the discipline as subjective, unreliable, and lacking the appropriate scientific foundation. The U.S Supreme Court *Daubert v. Merrell Dow Pharmaceuticals* (1993) requires judges to assess the basis and methodology of expert scientific testimony and decide its validity before allowing it to be applied. Considerations include "whether the theory or technique in question can be (and has been) tested, whether it has been subjected to peer review and publication, its known or potential error rate and the existence and maintenance of standards controlling its operation, and whether it has attracted widespread acceptance within a relevant scientific community" (*Daubert v. Merrell Dow* 1993). In 1999, the Supreme Court decision clarified the Daubert decision by extending its application to experts with technical or specialized knowledge in addition to scientific experts (*Kumho Tire Co. v. Carmichael* 1999). The trial judge may consider these standards in assessing the reliability of factors in a particular field of expertise (*Kumho v Carmichael* 1999). These court decisions resulted in legal challenges to the admissibility of fingerprint testimony and extensive debate of error rates (Cole 2004).

Errors in high profile cases are also a source of criticism. In 2004, Brandon Mayfield an Oregon attorney and a Muslim was held in connection with the Madrid bombing based upon latent fingerprint individualized by an FBI fingerprint analyst. The identification was later retracted leading to an intensifying debate on the reliability of latent print analysis (Cole 2004). Incorrect conclusions including 6 erroneous exclusions and 26 erroneous individualizations have been published by Triplett (2010) occurring from 1926 until 2009. These cases support critics' conclusion that friction ridge analysis and individualization is not infallible. Furthermore, errors can occur regardless of examiner experience, certification, or point characteristic standards (Cole 2004).

Questions of reliability and the impact of potential error in forensic science including friction ridge individualization led the U. S. Congress to commission a three-year study of forensic science by the National Academy of Science. On the subject of "individualization" the NAS committee stated, "With the exception of nuclear DNA analysis, however, no forensic method has been rigorously shown to have the capacity to consistently, and with a high degree of certainty, demonstrate a connection between the evidence and a specific individual source." The committee accepts that sufficient detail in friction ridges makes accurately concluding that two impressions originate from a common source as plausible. However, limited information regarding the reliability and accuracy of the analysis makes claims of zero error rates scientifically implausible. The Committee considers the process too broad, lacking in transparency and repeatability, and not guarded against bias. Following the steps in ACE-V does not ensure two analysts will arrive at the same conclusion. Therefore ACE-V does not qualify as a valid method of analysis. In addition, lack of standardization in examination practices and training does not ensure reliability (NAS, 2009).

Legal Scholars Saks, Blenkin, and Koehler discuss research to address subjectivity, probabilities, and uncertainties or levels of confidence. Koehler (2007) suggests calculation of industry wide error rates to include false positive error rate, false negative error rate, false positive percentage, and inconclusive rate. False positive error rate is the proportion of comparisons of pairs of impressions originating from the same source that result in an erroneous conclusion of individualization. Conversely, the false negative error rate is the proportion of comparisons of pairs of impressions originating from different sources that result in an erroneous conclusion of exclusion (SWGFAST 2012d). Error rates could provide jurors a reasonable estimate of the relative reliability of fingerprint analysis. Saks (2010) suggests observer effects as the greatest threat to forensic identification accuracy. Blenkin (2010) views the question of accuracy of forensic analysis is more important than uniqueness. Blenkin (2010) suggests using a likelihood ratio to establish a threshold and levels of certainty for examiner performance. A likelihood ratio is produced from a mathematical model that assesses the probability that two impressions have the same donor (Triplett 2010).

NAS and Expert Working Group on Human Factors in Latent Print Analysis Recommendations

Research specific to the discipline of friction ridge analysis suggested by the NAS includes how much a finger impression can vary from impression to impression and how impressions vary across the population. The committee called for probabilities of association to replace concepts of “uniquely associated with.” Rigorous scientific studies of experience, training, examiner ability, interpretation protocols and bias in analyses involving human interpretation is needed to estimate error rates. Error rates could also be used to assess the accuracy of forensic conclusions. Recommendations in the NAS (2009) report also include complete and thorough laboratory reports containing sources and degree of uncertainty with associated levels of confidence. Mandatory laboratory accreditation, examiner certification, quality control and quality assurance standards, as well as a national code of ethics are also recommended (NAS 2009). “The Expert Working Group on Human Factors in Latent Print Analysis was convened in December 2008 and charged with conducting a scientific assessment of the effects of human factors in forensic latent print analysis” (Expert Working Group on Human Factors in Latent Print Analysis [EWG], 2012). Expert Working Group recommendations are consistent with those made in the NAS report, research results, procedures adopted by the FBI laboratory in the wake of the Mayfield case, and guidelines outlined by SWGFAST.

Laboratory Accreditation and Quality Assurance Programs

ISO 17025:2005 standards and SWGFAST guidelines provide a baseline for the Crime Laboratories and law enforcement agencies performing friction ridge analysis to demonstrate a commitment to producing reliable quality test results. In addition, written procedures and technical records provide transparency as well as the ability to review and evaluate test results and examiner performance. According to the NAS committee laboratory accreditation and scientific working groups both have strategies to address error and misinterpretations (NAS, 2009). The EWG (2012) recommended “all forensic service providers should be accredited by a recognized accrediting body.” The NAS (2009) committee for forensic laboratories recommends the International Organization for Standardization, International Electrotechnical Commission (ISO/IEC) standard 17025:2005, “General requirements for the competence of testing and calibration laboratories” as the accreditation standard for forensic laboratories (2009). Accreditation organizations that offer ISO 17025 accreditation include the American Society of Crime Laboratory Directors Laboratory Accreditation Board (ASCLD/LAB), Forensic Quality Services (FQS), and the American Association for Laboratory Accreditation (A2LA).

The Scientific Working Group for Friction Ridge Analysis, Study and Technology, established in 1955, covers a broad spectrum of subjects including terminology, examiner qualifications, training, professional conduct, examination procedures, consultation, digital imaging, documentation and results reporting. Standards for blind verification, proficiency testing, and error rate measurement are also posted on the SWGFAST website. The SWGFAST (2012g) standard for a quality assurance program outlines a framework with many of the same elements featured in ISO 17025 accreditation requirements. This framework includes:

- Document and records management
- Training and education
- Evidence handling and safety
- Procedures for non-conforming work
- Proficiency testing program
- Technical and administrative reviews
- Corrective and preventative actions
- Management audits
- Testimony monitoring
- A code of ethics
- Quality control and calibration
- Method validation
- Standard operating procedures (SOP)

Recommendations made by the EWG for contemporaneous supporting notes sufficient to permit another examiner to assess the accuracy and validity of the conclusions of the original examiner as a measure of transparency are supported by both laboratory accreditation and SWGFAST. The ISO17025 requirements for technical records include recording and retaining original observations sufficient to establish an audit trail. An audit trail, or history from the original observation to the final value, must contain sufficient information to allow the test conditions to be repeated and identify factors affecting uncertainty. Audit trails also include the people conducting tests and correction tracking. These records must be sufficient to allow another competent analyst to evaluate and interpret the data (ISO/IEC 2005). Additional ASCLD/LAB – *International* (2011) supplemental requirements for latent print exam records, requires documentation of the sequence of each activity conducted and its results, controls and reagents used in fingerprint development, photography or digital imaging used and database searches. Prints analyzed, compared and evaluated must be included as well as the existence of all images not of value for comparison or analysis. Annotations are also maintained as examination records (ASCLD/LAB 2011). Similar requirements are listed in SWGFAST (2012e) standard for Analysis, Comparison, Evaluation, and Verification (ACE-V) documentation.

Following the Mayfield misidentification, revisions were made to the FBI Laboratory SOP. These revisions included separate sections for each step of ACE-V process and completion of a separate ACE sheet by the verifier. Examiners must document the analysis phase using photographs and case notes (OIG 2011). Similar subjects are covered by the SWGFAST (2012e) ACE-V friction ridge examination standard. These include factors affecting examinations, level of friction ridge detail, procedures for examination and sufficiency for conclusions. Procedures for examination further detail suitability, analysis, comparison, evaluation, verification, and reporting results. Sufficiency for conclusions includes details on quality, quantity, and decision making including a sufficiency graph (SWGFAST 2012e).

Examiner Training and Certification

The following recommendations in the area of training and certification were made by EWG (2012): A comprehensive testing program for examiners should include competency testing, certification testing, and proficiency testing. Forensic service providers should require personnel become certified through an accredited program. Accrediting bodies should evaluate the effectiveness of the Forensic services provider's examiner training program (EWG 2012). Currently, the International Association of Identification ([IAI] 2013) offers eight certification programs, including certification in Latent Print and Tenprint Fingerprint examination. Latent print certification has been offered since 1977 (IAI 2013). Research findings from the Dror et.al (2013) study's third experiment indicates that specific training such as training received by IAI certified examiners may reduce the biasing in suitability judgments. The ISO 17025 (2005) standard for assuring quality test results requires participation in an inter-laboratory comparison or proficiency test program. The ASCLD/LAB Supplemental Requirements (2011) requires all analysts pass a competency test prior to performing casework. These requirements include analysis of a sufficient number of unknown samples to evaluate the analyst ability. In addition, competency tests must cover the type and variety of questioned samples encountered in casework. Written and oral examinations demonstrating the analyst's knowledge and ability to convey results are also required (ASCLD/LAB, 2011). Competency testing for friction ridge examiner is also supported by SWGFAST (2012c). The SWGFAST (2012h) standard for minimum qualifications and training to competency outlines education and training objectives as well as minimum qualifications including overall time frames and time spent on conducting ACE-V examinations.

Both the NAS and EWG reports make recommendations for forensic service providers to adopt a code of ethics. The ASCLD/LAB-*International* Supplemental (2011) includes Guiding Principles for Professional Responsibilities of Crime Laboratories and Forensic Scientists. These principles cover professionalism, competency and proficiency, and clear communications (ASCLD/LAB, 2011).

Foundational/Probability Research

A number of scientific studies have been conducted since 2009. Feature selection processes utilized by examiner's in ACE-V are incorporated into various mathematical models. These studies provide a scientific foundation for friction ridge analysis. The Aldrich, Dutton, Dutton, & Taylor (2012) study objectives included using Geographical Information System (GIS) techniques to evaluate fingerprint features and derive probabilities to qualify latent fingerprint comparison conclusions. A variety of different analyses from statistics, geometry, geology, and ecology were adapted to characterize fingerprints. Methods of analysis included geometric morphometric spatial statistics, cartographic analysis and the Monte Carlo method. The Monte Carlo method is a computer algorithm used to quantify rare events that have correspondingly low probabilities of occurrence. Spatial analysis to characterize pattern types, minutiae distributions and ridge line configurations was conducted using over 1200 fingerprints;

102,000 minutiae; and 20,000 ridge lines from a population in Oregon (Aldrich et.al 2012).

The aim of the research conducted by Evett, Neumann, & Skerrett (2012) was to develop numerical evaluations of evidence categorically individualized and evidence classified as inconclusive. Evidence of insufficient quality or too little detail for opinions of individualization or exclusion could have corroborative value. The basic theory in this study involves the origin of an item of evidence in dispute (latent fingerprint) and a second item of evidence of known origin (exemplar). The two items of evidence either came from the same source or different sources. The two positions represent opposing propositions. Observations about the properties of both items of evidence contribute to a potential resolution of the dispute. A probability density function of the opposing propositions is used to assign a likelihood ratio value (Evett et.al, 2012). Two experiments were conducted utilizing 5 to12 minutiae on a smaller number of impressions and utilizing 3 to12 minutiae on a larger number of impressions. Validations experiments were carried out on the US National database of approximately 600 million fingerprints (Evett et.al 2012).

Srihari (2013) evaluates quantitative measures within ACE-V process related to the uniqueness of friction ridge features and individualization as an opinion. Graphical models are used to model probability distributions of friction ridge features and determine the rarity measured by random correspondence in a data base. Feature rarity can be combined with similarity of the questioned impression and the exemplar to determine the confidence in the conclusion. The models developed are useful in handling very complex data (Srihari, 2013).

All three research studies contain similar conclusions regarding probabilities and the number of minutia considered. Aldrich et.al (2012) concludes increasing the number of minutiae based upon spatial location in comparisons drastically decreases the false match probability. Probability of a false match would further decrease when minutiae type and direction are added to the calculation model (Aldrich et.al 2012). Similarly Evett et.al (2012) concludes considering a wider range of features makes the examination for discriminating. Srihari (2013) concludes that rarity of feature configurations can be inferred from probability distributions. As the number of minutia increase the rarity of their configurations increases pointing to uniqueness. Likelihood ratios provide support for examiner’s opinion of individualization or exclusion (Srihari, 2013).

Variations in the frequency, type, and location of friction ridge features useful to examiners were also revealed in the studies. Minutiae and ridgelines showed a greater density below the core (Aldrich et.al, 2012). The core is the approximate center of a fingerprint pattern (Triplett, 2010). Complexity of the pattern seems to influence the number of ridges in the lower region versus the upper region. And deltas occur more frequently in the lower region of the fingerprint (Aldrich et.al 2012). A delta, a triangular shaped feature, is defined by SWGFAST (2012i) as the point on a friction ridge at or nearest to the point of divergence of two type lines, and located at or directly in front of the point of divergence. Pattern types contain similarities in the distribution of bifurcations and ridge endings (Aldrich et.al, 2012). A bifurcation is the point at which a ridge divides into two ridges (Triplett, 2010). More complex pattern types such as double loop whorls have greater numbers of minutiae than less complex pattern types, such as arches. Comparisons of pattern types with comparable ridge flow such as loops and whorls were compared using various metrics. These comparisons indicated similarities suggesting the patterns originate through similar biological phenomena. From the MC method, the study determined the probability of a false match above the core is lower for the upper portion of fingerprints regardless of pattern type (Aldrich et.al, 2012). Study results could be used by examiners in determining the relative value of features noted and compared between a questioned impression and the exemplar.

The Evett et.al (2012) study results do not support the use of a numerical point standard. A minimum standard for 12 corresponding Level 2 details between a latent and known fingerprint was eliminated from the FBI SOP after the Mayfield misidentification (OIG 2011). Similarly, and consistent with this foundational research, SWGFAST (2012f) does not endorse the use of the number of minutiae or minutia counts as the sole criteria for a decision threshold. Minutia counts are a discrete and measurable aspect of all prints and included in consideration of quantity. However, a quality assessment of the clarity of the all levels of ridge detail in addition to such considerations as ridge path, areas with open fields, and selectivity of minutiae should be considered in conclusion decisions (SWGFAST 2012f).

Error Rate Research & Contextual Bias

Error rates and contextual bias are the subjects of scientific studies. A two-phase open study involving six fingerprint examiners and 60 trials was conducted by Langenburg (2009) in St Paul, Minnesota. Another study by Buscaglia, Hicklin, Roberts, & Ulery (2011) evaluated decisions made by friction ridge examiners and provided accuracy data in the form of error rates. Both studies involved examiners using the ACE-V method. The Buscaglia, et.al (2011) study was larger, involving 169 examiners ranging in experience from 6 to 35 years. The majority of participants in both studies were International Association of Identification certified examiners. Both studies used mated and non-mated impressions for the purposes of calculating error rates. A mated impression is one is intentionally collected from the same source. A non-mated impression is one intentionally collected from difference sources (SWGFAST 2012i). Fingerprint data approximated the typical range of casework and varied in both quantity and quality of ridge detail. The Buscaglia, et.al (2011) study was comparable to searches of an Automated Fingerprint Identification System (AFIS) system with 58 million subjects.

Both studies' results showed a higher level of accuracy or low positive error rates for individualization. Examiners in the Langenburg (2009) study demonstrated 100% accuracy individualization but the study involved a small number of examiners and a smaller number of comparisons. The overall false positive for the study results of the Buscaglia et.al (2011) study was 0.1%. Both studies showed higher false negative error rates. Accuracy of exclusions in the Langenburg (2009) study ranged for 67% to 86% in the two phases of the study. In the larger Buscaglia et.al (2011) study, a significant majority of examiners (85%) made at least one false negative error resulting in an overall false negative error rate of 7.5%. Examiners varied significantly in conclusion rates indicating a lack of consensus. Conclusion rates were higher among certified examiners (Buscaglia et.al 2011). A high degree of bias susceptibility towards exclusions in non-blind verifications was demonstrated by the Langenburg (2009) study. The Buscaglia et.al (2011) study results also suggest blind verification could significantly reduce false negative error rates.

The potential for cognitive and contextual bias in friction ridge examination was further explored in a study by Dror, Fraser-Mackensie, & Wertheim (2013). Bias and its effects appear to be strongest in instances where impressions are difficult to judge (Dror et.al 2013). Suitability used synonymously with sufficiency is an adequate amount of impression detail for further analysis or to reach a conclusion (Triplett 2010). Suitability judgments can be reliable in clear cut cases and unreliable when the impression is of poor quality or has significant distortion. Cognitive research indicates contextual information such as the presence of exemplars could impact judgments of suitability made by the examiner (Dror et.al, 2013).

Dror et. al (2013) conducted three experiments on suitability judgments made by latent fingerprint examiners using ACE-V process. Suitability conclusions and the effects of matching and non-matching comparison exemplars were examined. Experiments were conducted on 6,400 latent prints from 16 donor and 16 sets of exemplars. Participants were not aware the examinations were part of a study. In the first experiment, suitability of the prints was determined without exemplars, in the presence of a matching exemplar, and in the presence of a non-matching exemplar. Variations in the participant conclusions in the three tasks were compared. In addition, conclusions of IAI examiners were compared to those of non-IAI examiners. In the second experiment, impressions determined to be suitable or unsuitable without exemplars were presented to a second examiner to determine the effects of prior knowledge on the results. In the third experiment, examiners were asked to compare latent impressions with exemplars for a "major case." The examiner was asked to provide a second opinion on prints reported to have been identified by another examiner (Dror et.al 2013).

Suitability judgments were influenced by the presence of exemplars. The study showed the presence of a non-matching exemplars resulted in examiners more likely to conclude a print is suitable than when assessed in isolation. The opposite results were demonstrated in the presence of matching exemplars. Prior knowledge of another examiner's unsuitable conclusion increased the likelihood that a second examiner would reach the same conclusion. The same was not observed for prior knowledge of a suitable conclusion. Variations in results were slightly less for IAI examiners (Dror et.al 2013).

The variations found by the study are consistent with psychological literature indicating that contextual information automatically directs the attention of the individual performing a process. A structured linear, sequential approach in conducting the ACE portion of the ACE-V process is indicated by the experimental results. This approach, in avoiding exposing examiners to contextual information in the form of standards for comparison, has also been suggested in DNA analysis (Dror et.al 2013). The EWG (2012) also recommends implementing procedures to protect examiners from exposure to extraneous case information.

FBI Laboratory and SWGFAST Procedures for Bias

Following the misidentification of the Brandon Mayfield case the US Department of Justice (DOJ) Office of Inspector General (OIG) (2011) examined the standard operating procedures and methods used by the FBI Laboratory and recommended practical steps to improve friction ridge examination reliability and reduce future errors. The OIG (2011) concluded the errors resulted from their application of ACE-V methodology and demonstrate systematic problems with the laboratory operations. The OIG concluded the following were causes of the Mayfield misidentification:

> Unusual similarity between certain friction ridge details between the two known fingerprints; bias caused by the use of features observed in Mayfield's exemplar to change the original analysis of the Madrid latent fingerprint; over reliance on Level 3 details; reliance on inadequate explanations for differences between the exemplar and latent fingerprint; failure to consider the poor quality of the apparent similarities in Level 2 details between the latent fingerprint and the exemplar; failure to reexamine the identification after the FBI was informed that the Mayfield print was not a match in April 2004 (OIG, 2011).

Included among the recommendations was implementing a blind verification procedure to guard against bias (OIG 2011). The SWGFAST also acknowledges the possibility of bias in friction ridge examinations. In addition, it acknowledges subjectivity as an inherent part of the examination process (SWGFAST 2009). The SWGFAST (2012b) standard for a blind verification describes situations such as complex examinations and strong contextual influence in which blind verification should be required.

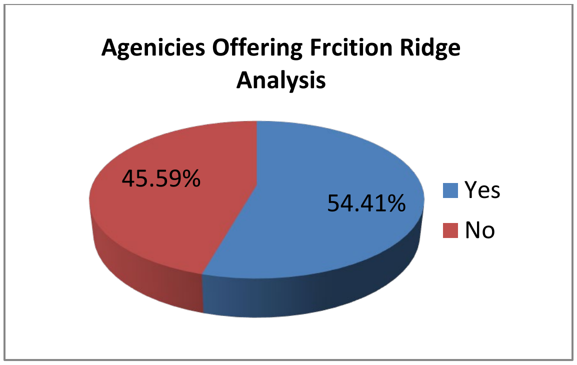
The FBI Laboratory requires examiners to complete and document their analysis of a questioned fingerprint before exemplar prints are introduced for comparison or evaluation. This approach known as a "linear" is not utilized by all laboratories using the ACE-V method (OIG 2011). Unlike the FBI Laboratory, SWGFAST standards do not include a strictly linear approach in applying ACE-V. The process instead includes a potential return to any previous phase. A flow chart outlining the steps and decisions is included in the SWGFAST standards for examination (SWGFAST 2012f). In addition, the FBI Laboratory now requires separate documentation of data relied upon in the comparison and evaluations steps that were not identified in the analysis step (OIG 2011). Consistent with this practice adopted by the FBI laboratory, any new information from re-analysis of latent images during the comparison phase of ACE-V should be documented in supplemental notes and dated according to SWGFAST (2012e). The EWG (2012) recommends modifications to the results of any stage of latent print analysis (e.g., feature selection, utility assessment, discrepancy interpretation) after seeing a known exemplar should be viewed with caution. Such modifications should be specifically documented as having occurred after comparison has begun (EWG, 2012). These procedures guard against the bias identified as a cause of the error in the Mayfield case (OIG 2011).

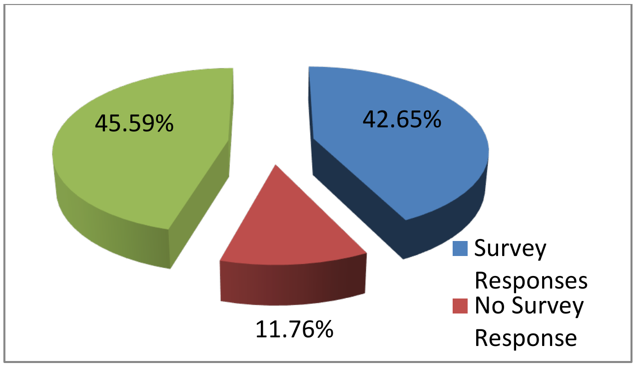
Methods

State law enforcement crime laboratories and sheriff's offices in Florida with fingerprint identification units were asked to participate in a survey of quality assurance practices, training, and analytical procedures used in the analysis of friction ridge skin impressions. Only agencies with testifying examiners utilizing the ACE-V method for testing were considered. Unit supervisors or personnel with technical oversight were interviewed by phone. Phone interviews ensured the appropriate personnel were interviewed and allowed for explanation of specific terminology used in the survey when needed. Fingerprint identification units within Sheriff's departments are not always responsible for developing or processing friction ridge impressions. In some of the units contacted for this survey these functions were performed by the crime scene units. As a result, survey respondents were not always aware if standard operating procedures exist or documentation maintained for friction ridge development or processing. Specific standards for quality assurance program policies and standard operating procedures were not defined. The consistency of these policies and compliance with accreditation standards cannot be evaluated. Police Departments with fingerprint identification units were not included in the survey.

Results

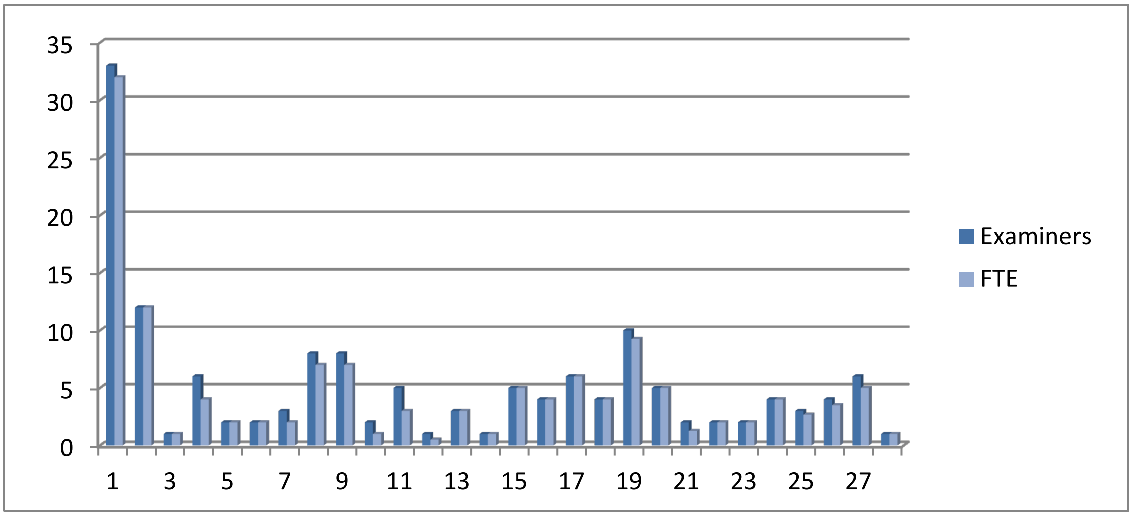
Florida has 67 county sheriff's offices and a state crime laboratory system with six locations. The state crime laboratory has statewide policies and procedures, therefore was considered one respondent in the survey results. All 68 agencies were contacted regarding friction ridge analysis. Of these 68 agencies, 37 have fingerprint identification units and 29 agencies responded to the phone survey.





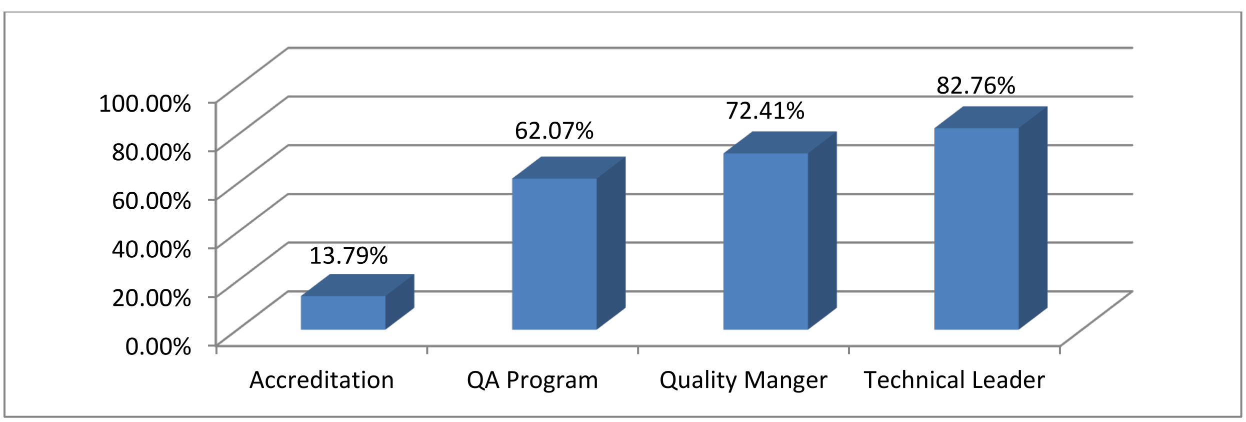
The survey response rate of agencies offering friction ridge analysis services was 78%. All agencies surveyed use ACE-V or fingerprint analysis. The number of examiners in each agency varied. The average number of examiners in the agencies surveyed was 5 including the state laboratory system and 4 without.

Number of Testifying Examiners

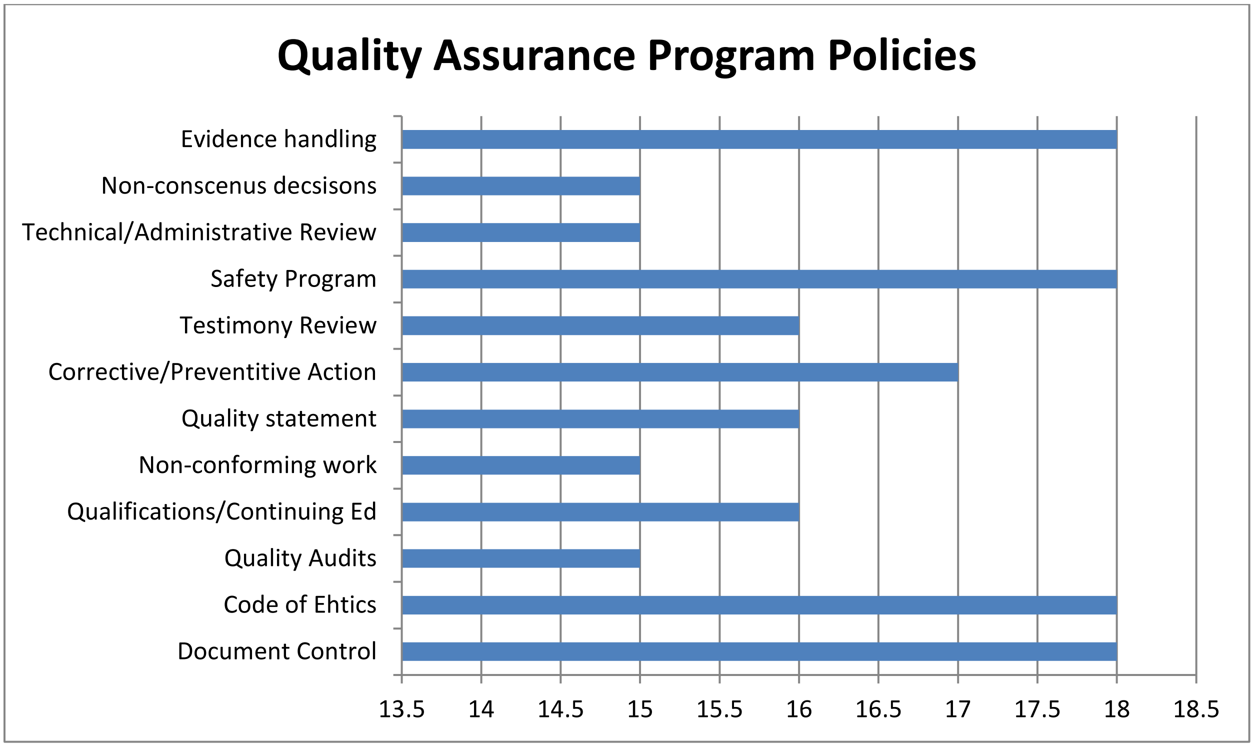


Full Time Equivalent (FTE) is an adjustment for part-time examiners and examiners with significant responsibilities outside fingerprint identification units. NAS and EWG recommendations included accreditation to ISO 17025 standards. Quality Assurance Programs, Quality Managers, and Technical Leaders are elements of a quality management system. Accreditation to ISO/IEC (2005) 17025 International Standards includes appointment of a Quality Manager. A Quality Manager is defined as a staff member with responsibility and authority to ensure a management system related to quality is implemented and followed at all times (ISO/IEC, 2005). A technical leader for the purpose of this survey is a staff member designated with technical responsibility for the friction ridge analysis unit. Designating technical responsibility for each forensic discipline is a requirement of ASCLD/LAB (2011) Supplemental requirements.

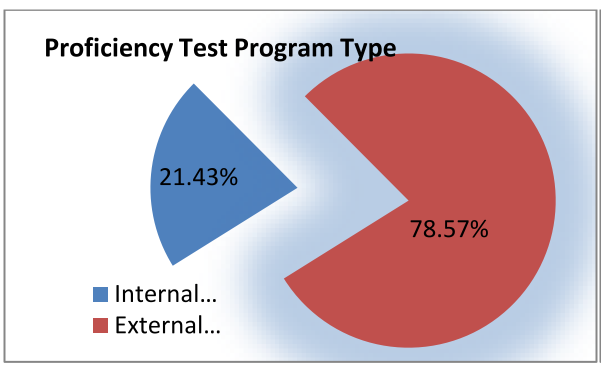
Agencies with Accreditation, QA Programs, Quality Mangers, Technical Leaders

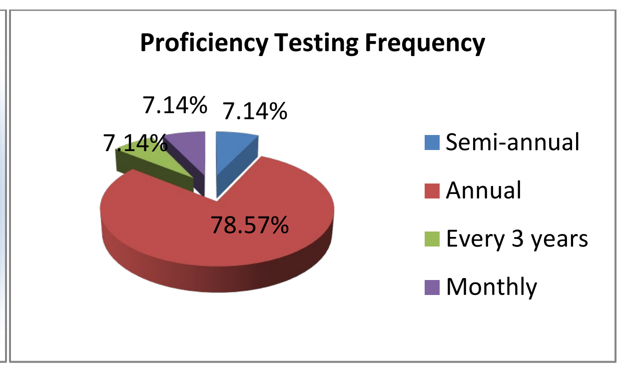


Policies with the Quality Assurance Program outlined by SWGFAST (2012g) and consistant with ASCLD/LAB-*International* accrediation were used to assess the scope of the 18 agencies with Quality Assurance Programs.

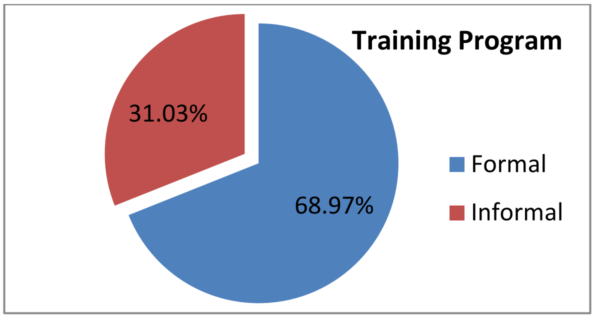


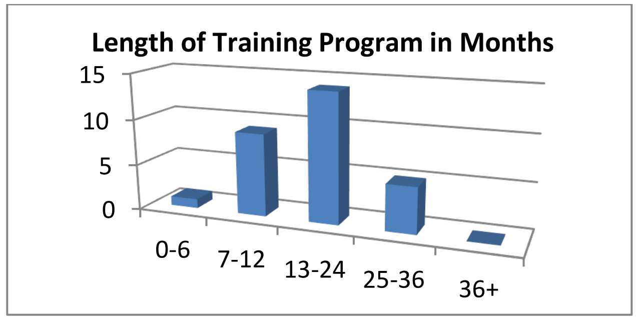
Another requirment for accreditation programs is participation in an ongoing proficiency testing. A total of 15 agencies participate in an on-going proficiency testing program. Eleven of these agencies also have Quality Assurance Programs and 4 agencies do not. Survey respondants participating in an on-going proficiency testing were asked if tests were prepared internally or administered externally. In addition, respondants were asked about the frequency in which proficiency testing was administered.



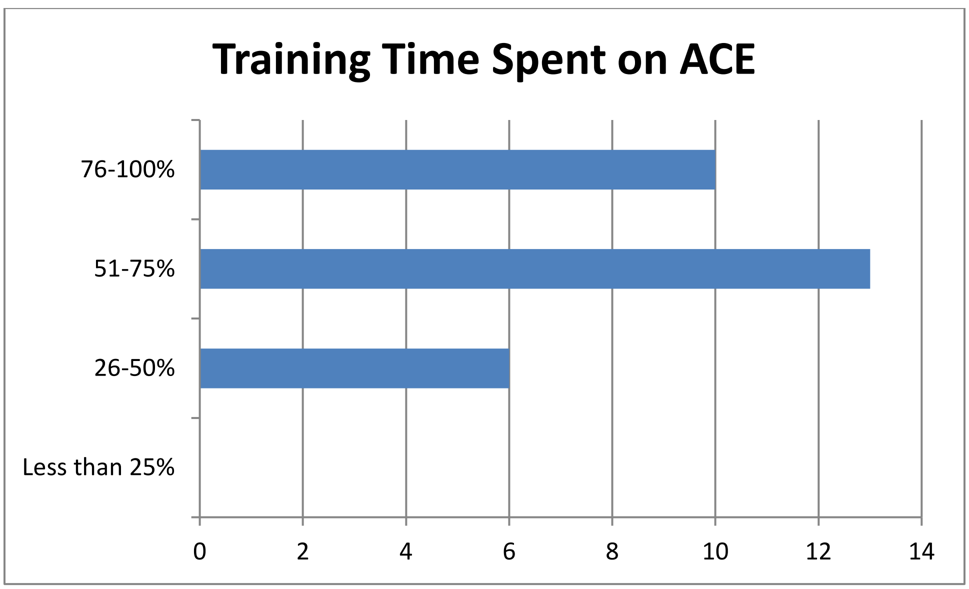


The NAS report also recommends examiner certification. Training programs in the NAS Report were characterized as highly varied. Of the 29 agencies surveyed 11 agencies (38%) required certification by the International Association of Identficiation. Survey respondants were asked to characterize examiner training programs as a formal program or informal mentoring.

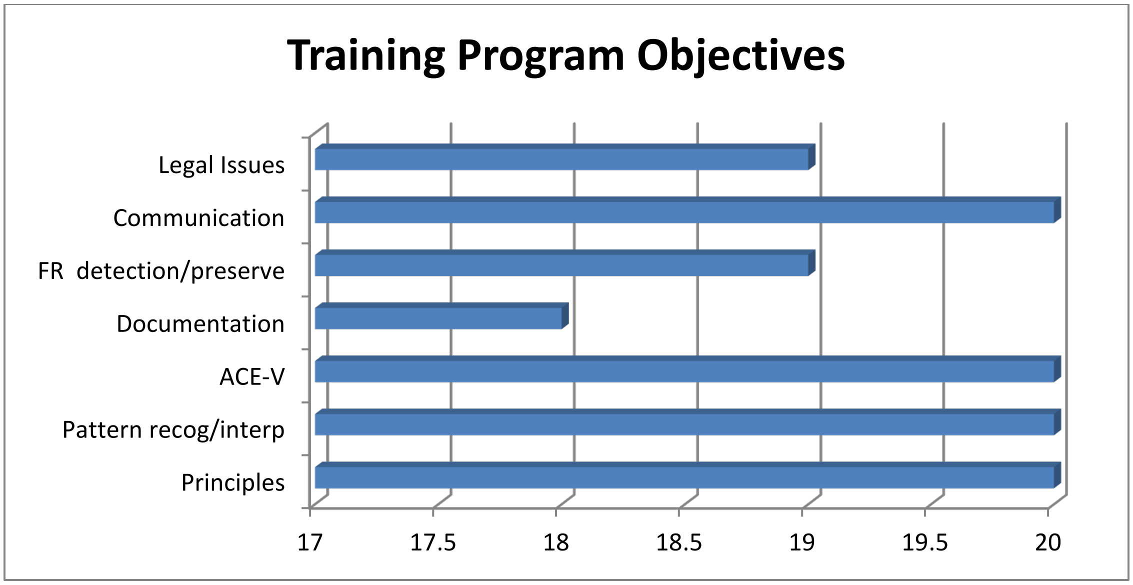




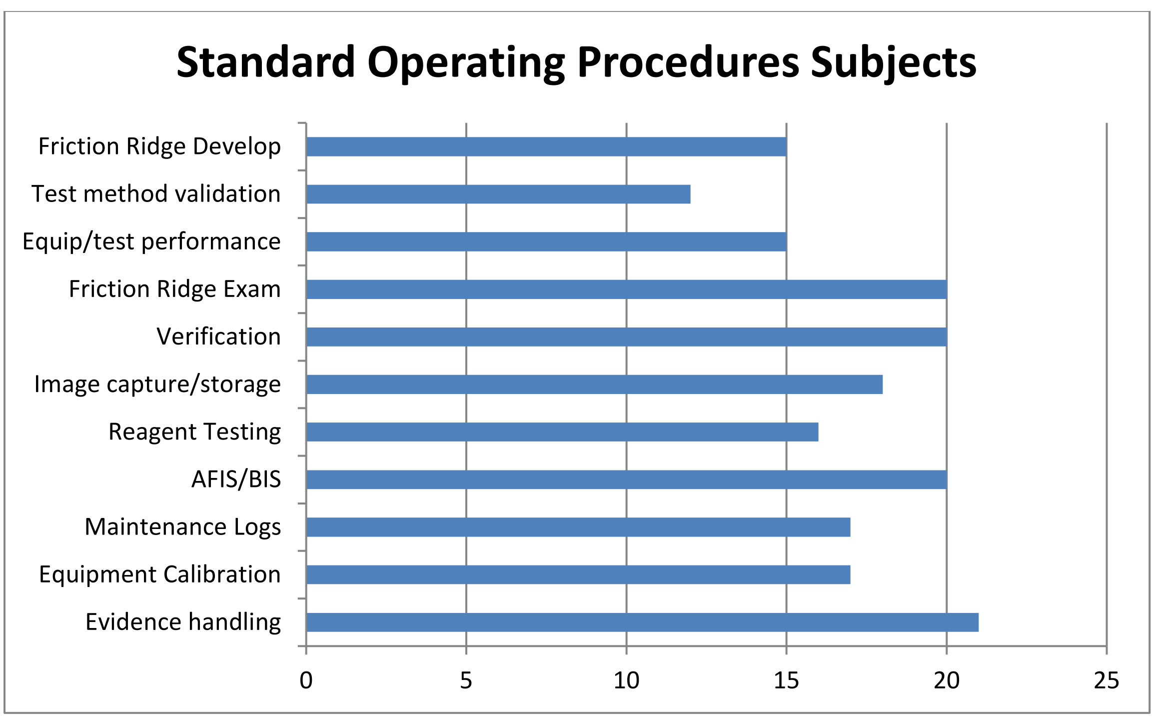
The SWGFAST (2012h) Standard for Minimum Qualifications and training to Comepentancy recommends a 1 to 2 year training program with the majority of time spent in training spent in the analysis, comparison, and evaluation (ACE) of impressions.



The scope of the objectives covered by formal training programs was further assessed based upon the SWGFAST (2012h) guidelines.

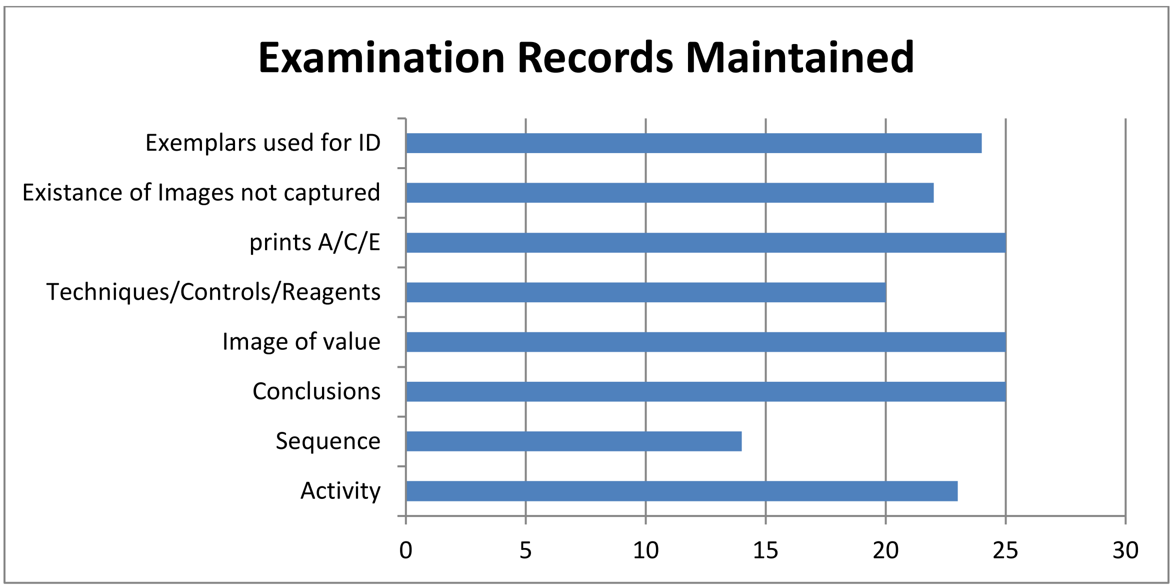


The ASCLD/LAB (2011) accreditation requirments requires examiners complete and pass a competency test prior to independent case work. Examiners in 26 of 29 agencies surveyed (90%) are competency tested prior to performing independant casework. Recommendations for standardized procedures and transparancy were also recommendations made in the NAS report and the EWG. Written SOPs for Friction Ridge Analysis are utilized by 21 of 29 (72%) of the agencies surveyed. The scope of the agency SOPs was further assessed based upon SWGFAST (2012g) guidelines. The SWGFAST guidelines include both the friction ridge impression development, preservation, and examination.

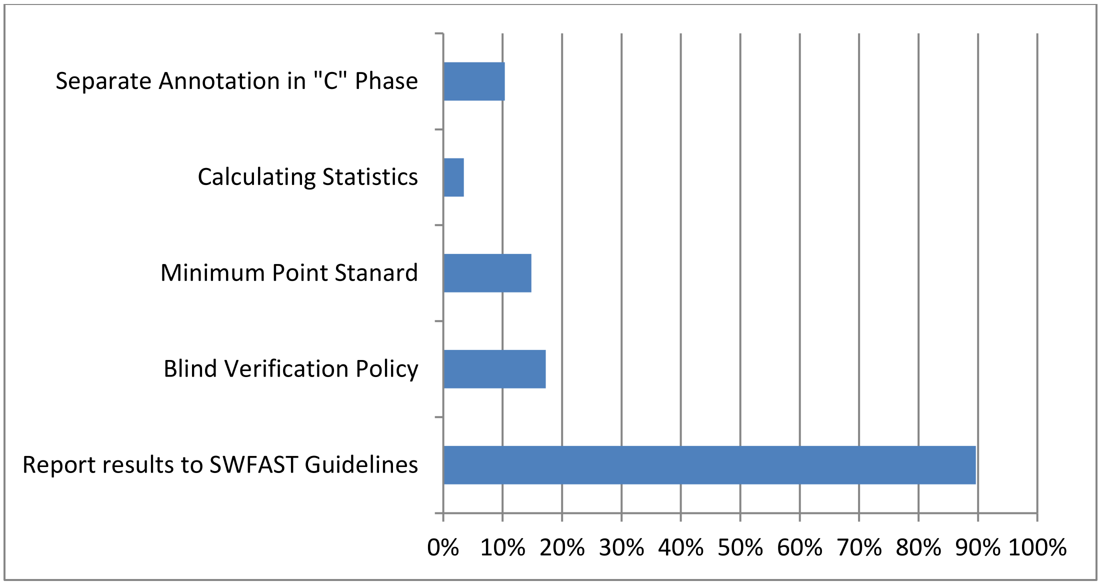


In a number of the agencies surveyed, development and preservation of friction ridge impressions is the responsibility of the crime scene units. As a result, fingerprint units SOPs did not always address these area. Crime Scene units performing these functions were not surveyed. As a result, the absence of an SOP for these functions within the fingerprint unit does not necessarily indicate SOP do not exist within the agency.

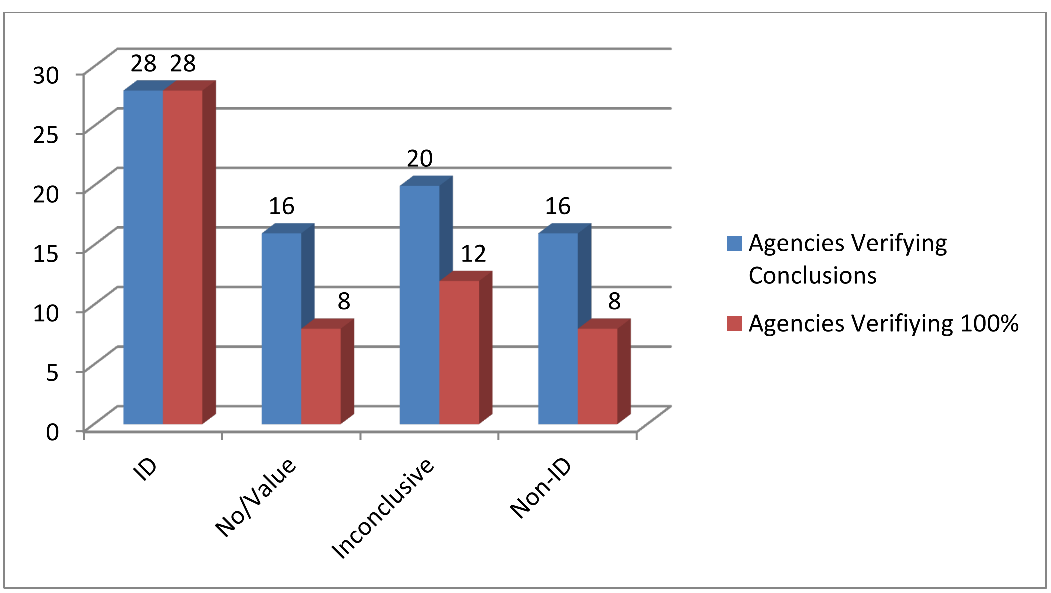
Transparancy can be addressed by maintaining examination records for review. The SWGFAST (2012e) guidelines and ASCLD/LAB (2011) Appendix C accreditaiton requirements specific to friction ridge analysis requires the maintenance of records sufficient to allow another competence examiner to interpret what was done and evaluate the conclusions reached. Such examination records are maintained by 25 or 29 agencies (86%) surveyed.



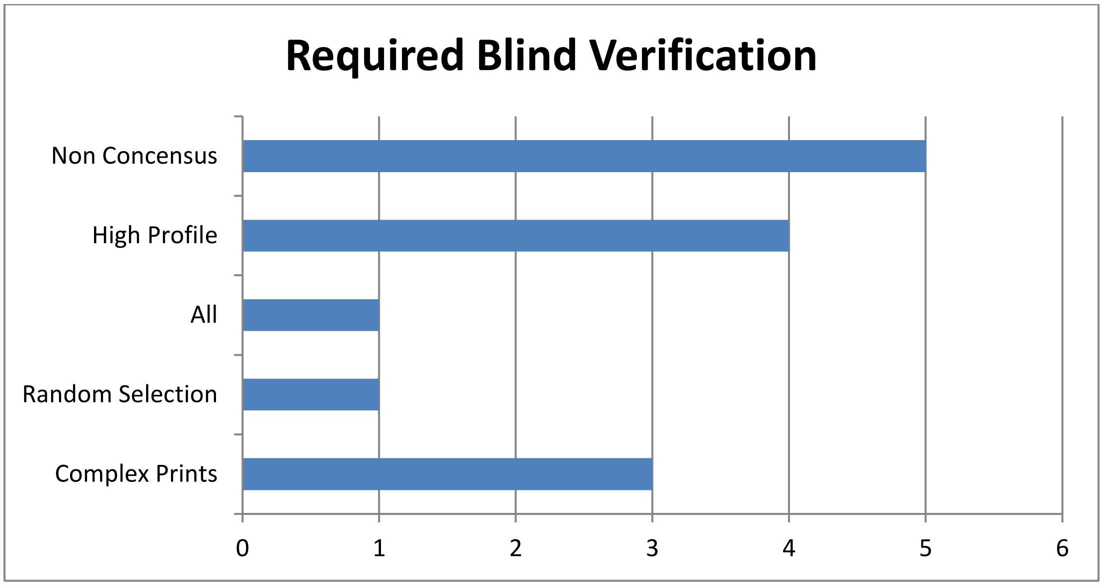
Scientific research conducted since 2009 reveals other areas concern, montioring and potential improvement. Error rate studies, contextual and confirmation bias research, and evaluation of the Mayfield missidentification indicates potenial value in implementing a blind verificaiton policy. Verificaiton of the conclusions reported varied among agencies. Agencies were surveyed in the following areas: reporting consistancy with SWGFAST (2012e) guidelines, conclusions verified, examination annotation, error rate statistics, and minimum point standards.



Three agencies responded as not reporting conclusions according to SWGFAST guidelines. Two of these agencies did not report exclusions or non-identifications and one agency did not report results as inconclusive. One agency did not verify any of its conclusions. This agency was not, but could potentially be excluded from the survey results as not using ACE-V since ACE-V methodology implies verification of at least some conclusions. Only one agency reported calculating error rate statistics. Of the five different statistics surveyed only positive and negative error rates were calculated by this agency. Verification of sufficiency (value/no value) conclusions, inconclusive conclusions, and exclusions also varied. Agencies verifying these conclusions but not providing a percentage sited criteria such as randomly selection and major/capital cases. Two agencies characterized conclusion verification frequency as rare.



The chart represents conclusions verified by agencies at any interval and those agencies verifying 100% of the conclusions reported. Among five agencies that have a blind verification policy, requirements for blind verification included non-consensus decisions, high profile cases, complex prints, or random selection. In one agency all verifications were blind verifications.



Discussion and Recommendations

Although a very limited number of agencies surveyed were accredited, a significant number of agencies demonstrate a commitment to quality through Quality Assurance Programs, written SOP, and rigorous training programs. This commitment to quality could be furthered by providing agencies with federal funding for accreditation programs and examiner certification.

The NAS report highlighted the need for scientific research especially in comparative identification disciplines such as friction ridge analysis. Research conducted since the NAS report begins to answer criticisms of ACE-V friction ridge analysis validity. Requirements for method validation by ISO/IEC (2005) 17025 accreditation standards include obtainable values for range and accuracy appropriate and relevant to the intended use. Examples given include detection limits or sensitivity, uncertainty, selectivity or test discrimination, repeatability, reproducibility, and robustness (ISO/IEC, 2005). Error rate study results provide evidence of ACE-V reliability and repeatability, as well as, identify potential areas for improvement. National Institute of Justice (NIJ) sponsored foundational research follows the same selection process examiners use in the ACE-V process. Probability results from this research demonstrate fingerprints contain levels of detail necessary for test discrimination and robustness to individualize fingerprint impressions with their source. Foundational research also demonstrates all fingerprint characteristics do not have equal value in evaluating impressions and a potential source. Appropriately, most fingerprint units within Florida do not apply minimum point standards as a detection limit. Additional research on the distribution, frequency, and variation of friction ridge characteristics should continue. Such research may result in tools helpful to the friction ridge examiner in developing appropriate detection limit standards not strictly based upon a numerical point value.

The EWG (2012) assessment and bias research shows human interaction with others, the work environment, and procedures are all potential sources of error in experience and judgment based analysis. Friction ridge examinations are no exception. Subjective elements cannot be separated from any examination process. Subjectivity, however, does make the process unreliable or invalid. Human factors potentially prominent in analysis outcomes should always be considered. Experimental science recognizes the existence of error and uncertainty. Errors and uncertainty not reduced through improved techniques should be estimated when possible for valid results. Identifying, quantifying, and tracking errors are routine parts of any comprehensive quality assurance program (EWG, 2012). These principles can and are routinely applied in good scientific practices. However, not all sources of error can be quantified or estimated. ASCLD/LAB references the Joint Committee for Guides of Metrology – Working Group 1 (JCGM/WG1), (2008) Evaluation of measurement data – Guide to the expression of uncertainty in measurement (GUM) in estimating uncertainties. The GUM defines uncertainty as “the dispersion of values around a quantity to be measured.” A measurement is determining the value of a particular quantity. Error in a measurement is the difference from its true value. The GUM particularly notes that error and uncertainty as not being synonymous (JCPM/WG1, 2008). Measurement uncertainty and associated levels of confidence apply to quantified or measured amounts. Friction Ridge Analysis does not involved quantified measurements. The NAS demand for reporting uncertainty and levels of confidence in reporting Friction Ridge analysis result is therefore misapplied. Measurement of lengths, distance between, or width of friction ridge characteristic variations can be estimated. These types of measurements although not quantified are used empirically by the examiner in the decision making process. However, the estimated uncertainties associated with quantified measurements of friction ridge characteristics made in computer modeling would provide little valuable information to jurors regarding the reliability of the test results. Uncertainty as a concept in reliability however is important. Attempting to identify all components of uncertainty to improve reliability should continually be pursued regardless of an inability to quantify. The contribution of these components and their inclusion in reasonable reporting should always be the goal of good science. Industry error rates would provide a more appropriate estimation of reliability for juries. Although industry error rates cannot be directly applied to individual cases it does serve as a reasonable estimate. Error rates are analogous to uncertainty estimations of quantity measurement results. Measurement uncertainty is estimated based upon the measurement process not a specific measurement event. Both examples, although far from perfect, provide information on test method reliability.

Error rate studies, the effects of contextual and confirmation bias, and effectiveness of suggested practices resulting from this research should continue. Error rates of agencies employing blind verification policies or employing separate annotation of impression characteristics in the comparison phase of ACE-V should be compared to agencies that do not. In addition, error and conclusion rates of agencies verifying 100% of conclusions reported could be compared to agencies with agencies with blind verification policies. These comparisons would assist in determining if expanding verification to include all conclusions is as or more effective than blind verification. Such techniques are labor intensive and require significant resource investments to accomplish. An appropriate evaluation would help agencies decide if the investment of resources is worthwhile or if resources should be directed elsewhere.

A demand for probabilities to replace conclusions currently reported by friction ridge examiners is premature. Proposing reporting probabilities of the association in friction ridge analysis as a hypothesis is appropriate. However, research results may not take the science in this predetermined direction. Friction Ridge analysis as currently conducted is analogous to a doctor's diagnosis. Individualization/identification of the source of the impression is similar to the identification of and illness. A doctor's diagnosis of an illness is based data from a variety of sources. Illness symptoms vary in number, type, and severity. Clinical tests results are also relied upon. The diagnosis is based upon evaluation of all such factors in its totality. A friction ridge examiner uses various techniques to develop impression characteristics. These characteristics vary and similar to a doctor conclusions, are based upon the number and type of characteristics in their totality. Different physicians may not rely on the same set of symptoms or test results in forming their diagnosis, yet come to the same conclusion. Two friction ridge examiners can also rely on different sets of characteristics to form the same conclusion regarding the impression's source. And a diagnosis just like a friction ridge examiner's conclusion can be incorrect. However, none of this makes the process unscientific.

In DNA analysis, probability represents the likelihood of the occurrence within the population based upon data and observation. Probability can also be used to accept or reject a hypothesis. Probability in measurement uncertainty is employed in the confidence level of the reported uncertainty. The range of values represented by the measured result and the uncertainty reported is the likelihood the true value lies within the range. Probabilities when appropriate in forensic testing assist a juror in assigning relative value assuming the interpretation or conclusion to which it is applied is correct. However, an incorrect interpretation or conclusion does not gain value in the application of a probability. Interpretation is fundamental in all scientific test methods. The best assurance of accuracy and reliability is the application of rigorous quality assurance practices and procedures. A quality assurance program can not eliminate error or prevent all inaccuracies, but it can reduce these factors and provide reasonable assurance of quality to a jury. It is important that the application of probabilities not be misapplied or their value misunderstood.

Probabilities from computer models evaluations of friction ridge characteristics provide valuable information about the discriminating value of specific characteristics selected for comparison. These computer models have significant potential in evaluating impressions of marginal value and could greatly expand the friction ridge impressions considered by juries in criminal cases. Continued research on friction ridge analysis probabilities for source association is needed. If probabilities of association are shown to be reliable then the use of probabilities should be adopted.

Chief of Forensic Services Mary Jane Havener started her career in 1987 as an environmental chemist with the Collier County Water Department. In 1999 she came to the Florida Department of Law Enforcement as a Crime Laboratory Analyst performing drug analysis in the Fort Myers Regional Crime Laboratory. In 2006 she was promoted to Crime Laboratory Analyst Supervisor and supervised Drug Chemistry and Evidence. She was promoted to her current position as Chief of Forensic Services of the Pensacola Regional Crime Laboratory in February of 2012. Mary Jane has a Bachelor of Science in Chemistry from the University of South Florida.

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Appendix A

I am conducting a survey as part of a research project for the Florida Criminal Justice Executive Institute Senior Leadership program. A research paper including these survey results will be published and accessible on the Florida Department of Law Enforcement public website. This survey is confidential. The identity of the respondent and their agency will not be included in the research paper. The purpose of this survey is to assess Florida law enforcement fingerprint units training, quality assurance procedures, and analytical protocols based upon SWGFAST guidance documents, ISO 17025 accreditation standards, and recently published research on friction ridge analysis.

SIZE / ACCREDITATION

1. Does your organization use ACE-V for fingerprint analysis? ___Yes ___No

2. How many testifying Latent Print examiners does your organization employ?

______ Total ______ Full Time Equivalent (FTE)

3. Is your Latent Print Unit accredited for laboratory testing (17025)? ___Yes ___No

(Yes) Which accreditation program?
___ASCLD/LAB
___FSQ
___Other (Please specify: ________________________________)

QUALITY ASSURANCE (skip all but Q5/Yes for 17025 accredited labs)

Q1. Does your organization have a written quality assurance program? ___Yes ___No

Q2. Indicate all policies and procedures covered by your quality assurance program:

___Document/Records Control
___Code of ethics
___Periodic Quality Audits
___Development/Cont. Ed.
___Non-conforming work
___Quality Policy Statement
___Corrective/Preventative Action
___Testimony Review
___Safety Program
___Technical and Admin Review
___Non-consensus decisions
___Evidence Handling

Q3. Does your organization have a Quality Manager? ____ Yes ____ No

Q4. Does your organization have a Technical Leader?____ Yes ____ No

Q5. Does your organization participate in on going proficiency testing?

___Yes ___No

(If Yes) Are proficiency tests
prepared internally _____ or obtained externally____

How often are proficiency tests administered?
___Semi-annually
___Annually
___Bi-annually
___Other (Please specify: ________________________________)

TRAINING

T1. Choose which best describes your training program:

______Formal, written program that includes written test, practical exercises, final competency testing (comparison final), supervised case work
______Informal Mentoring, on the job training with competent examiners/supervised casework

T2. Indicate all subject areas covered in your training program (skip if T1 = Informal):

___Principles and foundation (persistence, uniqueness, biology, physiology, history, criminal/civil application)
___Pattern recognition and interpretation
___Friction Ridge Examination (ACE-V)
___Documentation of the examination
___Friction Ridge detection/development and preservation
___Communication (Verbal and written)
___Legal issues

T3. What is the length of your training program?
___0-6 months
___7-12 months
___13-24 months
___25-36 months
___More than 36 months
___Not Applicable

T4. What amount of time in training is spent on the analysis, comparison, and evaluation of impressions?

___ Less than 25% ___ 26-50% ___ 51-75% ___ 76-100%

T5. Are examiner's competency tested prior to performing independent case work?

____Yes ____No

T6. Do you require certification by an outside organization? ____ Yes ___No

_____International Association of Identification (IAI)
_____American Board of Criminalists (ABC)
_____Other (Please specify: ___________________________________)

ANALYTICAL PRACTICES

A2. Does your organization have written SOP's? (skip if for 17025 accredited labs)

___ Yes ___ No

(Yes) Indicate all subjects covered by SOPs
___Evidence Handling
___Friction Ridge Impression Examination
___Equipment Calibration
___Equipment/Test Performance Checks
___Maintenance Logs
___Test method validation
___AFIS/BIS Searches
___Friction Ridge Impression Development
___Reagent Preparation/Testing/Storage/Disposal
___Impression image capture/storage
___Verification

A3. Does your organization maintain exam records to support conclusions reported which would allow another competent reviewer to evaluate and interpret what was done?

___Yes ___No

(Yes) Indicate which records are maintained for Friction Ridge examinations:
__Exam activity conducted
__Techniques/Controls/Reagents used
__Sequence of exam activities
__Pints analyzed/compared/evaluated
__Conclusions reached
__Existence/Disposition of prints not captured
__Images of prints of value
__Exemplars for individualization

A4. Does your organization report results consistent with SWGFAST guidelines?

____Yes ___No (Individualization, Exclusion, Inconclusive, No/Value)

A5. Please indicate the type of conclusions your organization verifies and percentage verified (skip if A3 = No):

____Individualization/Identification How much _______%
____Value/No Value (Suitability) How much _______%
____Inconclusive How much _______%
____Exclusions (Non-Identification) How much _______%

RECENT RESEARCH

R1. Does your organization have a Blind verification policy? ___Yes ___No

(Yes) Indicate all circumstances in which blind verifications are conducted:
___Single latent cases
___High profile cases
___Examiner & Verifier conclusions disagree
___Other (please explain) ______________________________________

R2. Does your organization use a strictly linear approach for ACE-V Exams?
___Yes ___No

R3. Do your Latent print examiners annotate characteristic noted in the comparison step of ACE-V separately from those noted in the analysis step? ___ Yes ____No

R4. Has your organization calculated any of the following statistics:
Positive error rate: ___Yes ___ No
Negative error rate: ___Yes ___ No
Positive Predictive Value: ___Yes ___ No
Negative Predictive Value: ___Yes ___ No
Conclusion Rate: ___Yes ___ No

R5. Does your organization use a minimum point standard for individualization/identification? ___Yes ___No

Thank you for your time and cooperation in participating in this survey.