Standard for Friction Ridge Examination Training Program

Friction Ridge Subcommittee
Physics/Pattern Scientific Area Committee
Organization of Scientific Area Committees (OSAC) for Forensic Science

OSAC Proposed Standard

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Prepared by
Friction Ridge Subcommittee
Organization of Scientific Area Committees (OSAC) for Forensic Science

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Disclaimer:

This document has been developed by the Friction Ridge Subcommittee of the Organization of Scientific Area Committees (OSAC) for Forensic Science through a consensus process and *proposed* for further development through a Standard Developing Organization (SDO). This document is being made available so that the forensic science community and interested parties can consider the recommendations of the OSAC pertaining to applicable forensic science practices. The document was developed with input from experts in a broad array of forensic science disciplines as well as scientific research, measurement science, statistics, law, and policy.

This document has not been published by a SDO. Its contents are subject to change during the standards development process. All stakeholder groups or individuals are strongly encouraged to submit comments on this proposed document during the open comment period administered by the Academy Standards Board (ASB).

Table of Contents

1. Introduction

1.1. This document has been developed with the objective of improving the quality and consistency of friction ridge examination practices.

1.2. This document is intended to serve as the minimum training standard for friction ridge analysts. Forensic Service Providers (FSPs) should develop their training manuals/procedures from these minimum standards. Each trainee should have a documented training plan with requirements to successfully complete training. Each analyst must retain documentation of successful completion of an approved training plan.

1.3. This document is not a training program; rather, it is an outline of training modules, topics, and content. This document is intended to serve as the minimum training standard. Compliance is expected from those organizations performing friction ridge examinations. Not all modules are required. Those not required will be explicitly identified as such in the module introduction.

1.4. There are Recommended Reading references listed at the end of each module. These references are intended as a suggested starting point for the trainee. It is not an exhaustive list of possible reading references; additional reading is encouraged.

1.5. In this document, the following verbal forms are used: "*shall*" indicates a requirement, "*should*" indicates a recommendation; "*may*" indicates permission; and "*can*" indicates a possibility or capability.

2. Scope

2.1. This document provides the minimum requirements for a friction ridge examination training program from which training manuals/procedures should be developed.

2.2. This document does not provide minimum training objectives or prescriptive lesson plans.

3. Terms and Definitions

4. General Requirements

4.1. General Training Requirements

4.1.1. A new trainee to the discipline shall have a Bachelor's degree from an accredited institution. At the time of hire, the trainee shall have 24 semester hours (or equivalent) in Science, Technology, Engineering or Mathematics (STEM) related coursework. Note: A degree in a natural or physical science is highly recommended.

This educational requirement shall be effective 18 months after the official publication date of this document.

4.1.2. Instructors and mentors shall have acquired and maintained proficiency for a minimum of one year in the topic areas that they instruct. Each agency shall have a written policy for selecting qualified instructors and mentors. Note: A certified Instructor's Development course is highly recommended.

4.1.3. The agency must have a policy to define passing criteria for all tests, practical exercises, and verbal assessments. A written training record of these assessments must be maintained by the agency for as long as the individual is employed as a friction ridge examiner. Ultimately, the trainee must be able to communicate an understanding of all the objectives and underlying principles by participating in a mock trial (See Legal Issues module).

4.2. History

Friction Ridge Examiners who testify in legal proceedings as expert witnesses are expected to have a historical understanding of the science of friction ridge examinations related to landmark events, scientific pioneers and their contributions, and the evolution of the friction ridge discipline. At a minimum, the trainee should have knowledge of:

4.2.1. Early discoveries and uses of Friction Ridges, e.g.:

4.2.1.1. Trademarks found in ancient pottery

4.2.1.2. Trademarks found in clay used on legal contracts

4.2.1.3. Finger seals used in China for the sealing of documents

4.2.1.4. Deed of a hand mark - Association of a fingermark and an individual's name

4.2.2. Early researchers and their significant contributions to establishing the foundation of friction ridge examination prior to the 19th century, e.g.:

4.2.2.1. Nehemiah Grew

4.2.2.2. Thomas Bewick

4.2.2.3. Marcello Malpighi

4.2.2.4. J.C.A. Mayer

4.2.3. Early pioneers and landmark events contributing to the application of friction ridge skin for personal identification purposes during the 19th century, e.g.:

4.2.3.1. Johannes E. Purkinje

4.2.3.2. Edmond Locard

4.2.3.3. Inez Whipple

4.2.3.4. Harris Hawthorne Wilder

4.2.3.5. William Herschel

4.2.3.6. Henry Faulds

4.2.3.7. Alphonse Bertillon

4.2.3.8. Francis Galton

4.2.3.9. Edward Richard Henry

4.2.3.10. Juan Vucetich

4.2.3.11. The Rojas Murders

4.2.3.12. The Thompson Receipt

4.2.3.13. Haque & Bose

4.2.3.14. Edmond Locard

4.2.3.15. Henry P. DeForest

4.2.3.16. FBI Identification Division

4.2.3.17. Origins of automated fingerprint identification systems

4.2.4. Modern era pioneers contributing to the scientific understanding and application of friction ridge examination for personal identification during the 20th century, e.g.:

4.2.4.1. Mary Holland

4.2.4.2. John A. Dondero

4.2.4.3. Harold Cummins

4.2.4.4. Alfred Hale

4.2.4.5. William Babler

4.2.4.6. Michio Okajima

4.2.5. Historically significant people, events, and items contributing to the evolution and maturation of the friction ridge discipline, e.g.:

4.2.5.1. 1904 World's Fair (fingerprint significance)

4.2.5.2. Inspector John Ferrier

4.2.5.3. The Will/William West Case

4.2.5.4. The Belper Committee

4.2.5.5. The Troup Committee

4.2.5.6. Fingerprint Identification of the Deceased

4.2.5.7. FBI Identification Division

4.2.5.8. Sinking of the USS Squalus

4.2.5.9. 1940 Pan American Airliner

4.2.5.10. FBI Disaster Squad

4.2.5.11. IAI Resolutions related to the basis for identification

4.2.5.12. ACE-V

4.2.5.13. Roy Huber

4.2.5.14. David Ashbaugh

4.2.6. Historical biometric classification (body and fingerprints) and their evolutionary significance and relationship to one another, e.g.:

4.2.6.1. Nine main groups of fingerprint patterns (Johannes Purkinje)

4.2.6.2. Basic precursor to the Henry Classification system

4.2.6.3. Syllabic System of classifying fingerprints (Henry Faulds)

4.2.6.4. Continued development and evolution of a fingerprint classification system

4.2.6.5. Bertillon System of Anthropometry (Alphonse Bertillon)

4.2.6.6. Eleven different body measurements

4.2.6.7. Transition from the Bertillon system to fingerprint classification systems

4.2.6.8. The Will West and William West story

4.2.6.9. Tripartite Fingerprint Classification System (Francis Galton)

4.2.6.10. Alphabetical enumerations

4.2.6.11. Inclusion into the Bertillonage files at Scotland Yard

4.2.6.12. Argentinian Fingerprint Classification System (Juan Vucetich)

4.2.6.13. Primary and Secondary classifications

4.2.6.14. Argentina's classification distinction, first to solely use fingerprints

4.2.6.15. Henry Classification System

4.2.6.16. NCIC Classification System

NOTE: Modern classification systems, such as the Henry Classification System and the National Crime Information Center (NCIC) system, are included in the Fingerprint Classification module.

4.2.7. Recommended Reading:

Ashbaugh, David R. Quantitative-Qualitative Friction Ridge Analysis. Chapter II – *History of Friction Ridge Identification.* Boca Raton: CRC Press, 1999

Barnes, Jeffery. The Fingerprint Sourcebook. Chapter 1 – *History.* National Institute of Justice. 2011

4.3. Biology

Friction Ridge Examiners need to have a comprehensive understanding of the two primary theories underlying the use of friction ridge impressions as a means of identification: 1) friction ridge impressions exhibit discriminating features that can be used to distinguish between individuals and 2) the arrangement of friction ridges persists throughout the lifetime of an individual. At a minimum, the trainee shall:

4.3.1. Understand the embryology of friction ridge skin and the theoretical basis of the discriminability of friction ridge impressions, with specific emphasis on:

4.3.1.1. Embryological development

4.3.1.2. Volar pad and friction ridge formation and timing

4.3.1.3. Morphogenesis of primary and secondary ridges

4.3.2. Understand the mechanical structure of friction ridge skin and the theoretical basis of the persistence of the friction ridge skin.

4.3.3. Understand the impact of biological distortions on the appearance of friction ridge skin, with specific emphasis on:

4.3.3.1. Changes due to the effects of damage (intentional or accidental)

4.3.3.2. Changes due to the effects of aging

4.3.3.3. Changes due to occasional features (e.g. warts, wrinkles)

4.3.3.4. Persistency and reproducibility of these biological distortions in impressions

4.3.4. Understand the genetic and epigenetic influences on the resulting appearance of friction ridge skin, with specific emphasis on:

4.3.4.1. The similarities and differences between friction ridge impressions from monozygotic twins

4.3.4.2. The biological causes that contribute to variability

4.3.5. Recommended Reading

Champod, Christophe et al. Fingerprints and Other Ridge Skin Impressions (2nd Edition). Chapter 1. CRC Press, Boca Raton, 2016

Babler, William. *Embryonic Development of Epidermal Ridges and Their Configurations*. Birth Defects: Original Article Series. 27(2) 95-112, 1991

Maceo, Alice and Wertheim, Kasey. Friction Ridge Sourcebook. Chapter 2 – *Anatomy and Physiology of Adult Friction Ridge Skin* and Chapter 3 – *Embryology and Morphology of Friction Ridge Skin*. National Institute of Justice. 2011

4.4. Introduction to Friction Ridge Impressions

Friction ridge trainees need to observe and understand the macro and micro levels of data-rich friction ridge impressions and how to apply the data during examinations. Macro information includes the shapes of impressions based on hand and foot morphology (i.e. size and outline of the impressions), flexion creases, patterns, deltas, ridge counts, and dominant ridge flows. Micro information includes ridge paths, minutiae, ridge morphology, crease morphology, scar morphology, and morphology of other occasional features.

The trainee shall successfully demonstrate competency for each section prior to progressing to the next section. At a minimum, the trainee shall understand the following topics:

4.4.1. Fingerprints

4.4.1.1. Known Fingerprints

4.4.1.1.1. Understand and demonstrate knowledge of the three primary pattern types and their distribution in the population

4.4.1.1.2. Understand and demonstrate knowledge of the various sub-classifications of fingerprint patterns

4.4.1.1.3. Understand proper distal orientation of fingerprints

4.4.1.1.4. Understand proper left-right determination of fingerprints

4.4.1.1.5. Understand the significance of cores and deltas during comparison

4.4.1.1.6. Understand the significance of ridge counts during comparison

4.4.1.1.7. Understand the significance of micro features during comparison

4.4.1.1.8. Understand and demonstrate the ability to detect variability in appearance of known prints from the same and different source skin

After the trainee has learned the macro and micro levels of information in rolled fingerprints and demonstrated competency in comparing rolled fingerprints, clear impressions of fingerprints that bear limited focal points (e.g. core is visible but not the delta) shall be compared against rolled fingerprints.

4.4.1.2. Partial Fingerprints

4.4.1.2.1. Be familiar with the general shapes of partial, unknown fingerprints

4.4.1.2.2. Understand the significance of available ridge flow information for assistance with left-right hand determination

4.4.1.2.3. Understand and demonstrate proper recognition of distal orientation of partial fingerprints

4.4.1.2.4. Understand and demonstrate proper selection of effective target groups using macro and micro features

4.4.1.2.5. Understand the significance of available focal points and ridge counts to narrow the pool of possible donors

4.4.1.2.6. Understand how to establish search parameters in corresponding regions of the known prints

4.4.1.2.7. Understand how to use macro and micro features to formulate source conclusions

4.4.1.2.8. Understand and demonstrate the ability to detect variability in appearance of impressions of the same and different source skin

After the trainee has demonstrated competency in the comparison of fingerprints with limited focal points and ridge counts, clear impressions of the edges and tips of fingers shall be compared against fully rolled fingerprints.

4.4.1.3. Tips and Edges of Fingerprints

4.4.1.3.1. Be familiar with the general shapes of impressions from the edges and tips of the finger

4.4.1.3.2. Understand the significance of available ridge flow information for left-right determination

4.4.1.3.3. Understand and demonstrate proper recognition of distal orientation of impressions from the edges and tips of the finger

4.4.1.3.4. Understand how to establish search parameters in corresponding regions of the known prints

4.4.1.3.5. Understand how to use macro and micro features to establish effective target groups

4.4.1.3.6. Understand how to use macro and micro features to formulate source conclusions

4.4.1.3.7. Understand and demonstrate proper recognition of when additional known prints are needed to complete comparisons

4.4.1.3.8. Understand and demonstrate the ability to detect variability in appearance of impressions of the same and different source skin

4.4.2. Proximal and Medial Phalange Prints

4.4.2.1. Be familiar with the general shapes of impressions from the lower portions of the finger

4.4.2.2. Understand the significance of available ridge flow and crease information to establish search parameters in corresponding regions of the known prints

4.4.2.3. Understand how to use macro and micro features to establish effective target groups

4.4.2.4. Understand how to use macro and micro features to formulate source conclusions

4.4.2.5. Understand and demonstrate proper recognition of additional known prints needed to complete comparisons

4.4.2.6. Understand and demonstrate the ability to detect variability in appearance of impressions of the same and different source skin

4.4.3. Palm Prints

4.4.3.1. Full Palm Prints

4.4.3.1.1. Be familiar with the major regions: interdigital, hypothenar, and thenar

4.4.3.1.2. Be familiar with the frequency of patterns in the palm regions

4.4.3.1.3. Be familiar with the frequency and positions of deltas in the palm regions

4.4.3.1.4. Be familiar with major ridge flows of the palm regions

4.4.3.1.5. Be familiar with the position and variation of the creases in the palms (regular flexion creases, irregular flexion creases and secondary creases)

4.4.3.2. Partial Palm Prints

4.4.3.2.1. Understand the significance of available ridge flow information for left-right determination of palm prints

4.4.3.2.2. Understand and demonstrate proper recognition of the shapes of partial prints from each palm region

4.4.3.2.3. Understand and demonstrate proper recognition of distal orientation of partial palm prints

4.4.3.2.4. Understand how to use macro features to determine anatomical region

4.4.3.2.5. Understand how to use macro features to determine distal orientation

4.4.3.2.6. Understand and demonstrate the ability to properly determine when to widen search parameters to include alternative handedness, anatomical regions, or orientations

Once the trainee has become proficient in determining the anatomical region, distal orientation, and handedness of palm prints, the next set of practical exercises shall include comparison of partial palm prints to exemplar palm prints. The trainee shall also learn to recognize when additional exemplar prints are needed to complete the comparisons.

4.4.3.3. Palm Print Comparisons

4.4.3.3.1. Understand and demonstrate the ability to use minutiae to establish efficient search parameters

4.4.3.3.2. Understand and demonstrate when to widen search parameters (alternative handedness, anatomical regions, or orientations)

4.4.3.3.3. Understand and demonstrate how to use macro and micro features to establish effective target groups

4.4.3.3.4. Demonstrate the use of macro and micro features to associate impressions

4.4.3.3.5. Demonstrate the use of macro and micro features to exclude impressions

4.4.3.3.6. Understand and demonstrate the ability to recognize when additional known prints are needed to complete comparisons

4.4.3.3.7. Understand the variability in appearance of impressions of the same and different source skin

4.4.4. Foot Prints

4.4.4.1. Full Foot Prints

4.4.4.1.1. Be familiar with the major regions: toes, hallucal, interdigital, hypothenar (proximal & distal), thenar (proximal & distal) and calcar

4.4.4.1.2. Be familiar with the frequency of patterns in the foot regions

4.4.4.1.3. Be familiar with the frequency and positions of deltas in the foot regions

4.4.4.1.4. Be familiar with major ridge flows in the foot regions

4.4.4.1.5. Be familiar with the position and variation of creases in the feet

4.4.4.2. Partial Foot Prints

4.4.4.2.1. Understand the significance of available ridge flow for left-right determination of partial foot prints

4.4.4.2.2. Understand and demonstrate proper recognition of the shapes of partial prints from each foot region

4.4.4.2.3. Understand and demonstrate proper recognition of distal orientation of partial foot prints

4.4.4.2.4. Understand how to use macro features to determine anatomical region

4.4.4.2.5. Understand how to use macro features to determine distal orientation

4.4.4.2.6. Understand and demonstrate the ability to properly determine when to widen search parameters to include opposite foot, additional anatomical regions, or additional orientations

4.4.4.2.7. Understand and demonstrate the ability to properly distinguish between palm and foot impressions

4.4.4.2.8. Understand and demonstrate the ability to properly distinguish between finger and toe impressions

Once the trainee has become proficient in determining the anatomical region, distal orientation, and left-right of foot prints, the next set of practical exercises shall include comparison of partial foot prints to foot exemplars. The trainee shall also learn to recognize when additional exemplar prints are needed to complete the comparisons.

4.4.4.3. Foot Print Comparisons

4.4.4.3.1. Understand and demonstrate the ability to use macro features to establish efficient search parameters

4.4.4.3.2. Understand and demonstrate when to widen search parameters (opposite foot, additional anatomical regions, or additional orientations)

4.4.4.3.3. Understand and demonstrate how to use micro features to establish effective target groups

4.4.4.3.4. Demonstrate the use of macro and micro features to associate impressions

4.4.4.3.5. Demonstrate the use of macro and micro features to exclude impressions

4.4.4.3.6. Understand and demonstrate the ability to recognize when additional known prints are needed to complete comparisons

4.4.4.3.7. Understand the variability in appearance of impressions of the same and different source skin

4.4.5. Recommended Reading

Champod, Christophe et al. Fingerprints and Other Ridge Skin Impressions (2nd Edition). Chapters 1 and 2. Appendices A and B. CRC Press, Boca Raton, 2016

Cowger, James F. Friction Ridge Skin: Comparison and Identification of Fingerprints. Chapter 7. CRC Press, New York. 1993
The Federal Bureau of Investigation. *The Science of Fingerprints;* Types of Patterns and Their Interpretation, pgs. 5 – 63. U.S. Department of Justice, U.S. Government Printing Office, Washington DC, 1979

Cummins, Harold and Midlo, Charles. Finger Prints, Palms, and Soles: An Introduction to Dermatoglyphics (3rd Edition). Chapter 6 - Soles. Research Publishing Company, South Berlin. Mass, 197

4.5. Fingerprint Classification

The methods most commonly accepted in the United States are the Henry System of Classification and the National Crime Information Center (NCIC). Only trainees that are tasked with classifying fingerprints shall complete this module and at a minimum, shall understand the following:

4.5.1. Henry Classification System (Edward Henry)

4.5.1.1. Understand and demonstrate the ability to determine the Primary, Secondary, Sub-secondary, Major, Final and Key classifications

4.5.1.2. Be familiar with the success and the pervasive use of the Henry Classification System

4.5.2. Federal Bureau of Investigation National Crime Information Center (NCIC)

4.5.2.1. Understand and demonstrate the ability to determine the alphanumeric classification system specific to each finger

4.5.2.2. Understand and demonstrate the ability to determine the 20-character code consisting of all fingers

4.5.2.3. Be familiar with the scope and efficacy of the classification system

4.5.3. Recommended Reading

The Federal Bureau of Investigation. The Science of Fingerprints. The Classification Formula and Extensions, pgs. 80 – 91. U.S. Department of Justice, U.S. Government Printing Office, Washington DC, 1979

4.6. Exemplars

Exemplars are intentional legible recordings of friction ridge skin. All Friction ridge trainees shall be familiar with how to legibly record friction ridge skin. Only those trainees that are tasked with obtaining exemplar prints shall demonstrate the ability to properly record exemplar prints and at a minimum shall understand the following:

4.6.1. General

4.6.1.1. Understand the reasons exemplars are required

4.6.1.2. Understand the importance of obtaining legible friction ridge impressions for comparison and the impact of:

4.6.1.2.1. Incomplete recording of friction ridge skin

4.6.1.2.2. Missing anatomical sources

4.6.1.2.3. Exemplar distortions (unclear recordings, digital capture, facsimile records, etc.)

4.6.1.2.4. Limitations of preservation techniques

4.6.1.2.5. Demonstrate the ability to recognize when exemplars have been fully and legibly recorded.

4.6.2. Preservation Techniques

4.6.2.1. Exemplars

4.6.2.1.1. Be familiar with equipment and techniques to obtain inked, live scan, or other types of exemplars

4.6.2.1.2. Understand necessary documentation when obtaining exemplars

4.6.2.1.3. Understand and (if applicable) demonstrate the proper methodology for:

4.6.2.1.3.1. Obtaining fingerprint exemplars

4.6.2.1.3.2. Obtaining palm print exemplars

4.6.2.1.3.3. Obtaining footprint exemplars

4.6.2.1.3.4. Obtaining complete friction ridge (Major Case) exemplars

4.6.2.2. Recording friction ridge skin from deceased individuals

4.6.2.2.1. Understand and (if applicable) demonstrate the proper methodology for:

4.6.2.2.1.1. Obtaining exemplars from decomposed friction ridge skin

4.6.2.2.1.2. Obtaining exemplars from macerated friction ridge skin

4.6.2.2.1.3. Obtaining exemplars from desiccated friction ridge skin

4.6.2.2.1.4. Obtaining exemplars from charred friction ridge skin

4.6.3. Recommended Reading

Cutro, B.T. Friction Ridge Sourcebook. Chapter 4 - *Recording living and post-mortem friction ridge exemplars*. National Institute of Justice. 2011

4.7. Latent Print Processing

The following training module will address latent print processing and development. Depending on agency operations and capabilities, not all latent print examiners are expected or required to process, develop, and preserve latent print impressions from physical evidence; however, all latent print examiners need to understand the effects of latent print processes and preservation methods as they directly impact the ability to analyze friction ridge impressions. Section I applies to latent print examiners that do not perform processing, development or preservation of latent print impressions. Sections I & II apply to latent print

examiners that do perform processing, development or preservation of latent print impressions.

Each agency should have a requisite number of supervised cases for the trainee to complete that sufficiently prepares that trainee for autonomous casework.

4.7.1. Section I – At a minimum, all trainees shall:

4.7.1.1. Be familiar with processing, development and preservation methods utilized by the organization and/or submitting organizations with respect to:

4.7.1.1.1. How the methods are applied

4.7.1.1.2. The order in which the methods are applied

4.7.1.1.3. The properties of the latent print residue, substrate, and or method that facilitate the development of the impression.

4.7.1.1.4. The impact of each method (and combinations thereof) on the appearance of the impression.

4.7.1.2. Understand the impact of the following on the development and appearance of friction ridge impressions:

4.7.1.2.1. Substrate type

4.7.1.2.2. Substrate material composition

4.7.1.2.3. Substrate surface attributes

4.7.1.2.4. Environmental conditions

4.7.1.2.5. Collection, preservation and handling

4.7.1.3. Using practical exercises, demonstrate the ability to recognize relevant effects to the appearance of friction ridge impressions due to various processing methods utilized by the organization and/or submitting organizations.

4.7.2. Section II – At a minimum, trainees that perform processing, development or preservation methods shall:

4.7.2.1. Understand and demonstrate how to properly apply the methods using appropriate procedures and sequence with respect to other methods.

4.7.2.2. Understand and demonstrate how controls (positive and negative) are utilized to test the efficacy of chemicals or chemical solutions.

4.7.2.3. Understand the optimum environmental conditions for each method, e.g. temperature and humidity.

4.7.2.4. Understand and demonstrate how to properly prepare chemicals and solutions relevant to the methods utilized.

4.7.2.5. Understand relevant health and safety considerations with respect to proper handling, storage, and use of the methods utilized, to include:

4.7.2.5.1. Proper interpretation of Safety Data Sheets (SDS)

4.7.2.5.2. Proper utilization of ventilation (fume hoods)

4.7.2.5.3. Proper use and maintenance of eye wash stations and personal safety showers

4.7.2.5.4. Proper use and maintenance of personal protective equipment (PPE)

4.7.3. Recommended Reading

Yamashita, Brian; French, Mike. Friction Ridge Sourcebook. Chapter 7 - *Latent Print Development*. 2011.

Home Office Centre for Applied Science and Technology (CAST). Fingerprint Visualization Manual. Centre for Applied Science and Technology (CAST), London, 2014

Champod, Christophe et al. Fingerprints and Other Ridge Skin Impressions (2nd Edition). Chapter 4. CRC Press, Boca Raton, 2016.

4.8. Examination Method

The process by which fingerprint examiners make decisions when performing examinations between two impressions is achieved by assessing the quantity, clarity, and rarity of features as well as the correspondence of those features. At a minimum, the trainee shall understand the following concepts:

4.8.1. Value Determination for Comparison

4.8.1.1. Understand the significance of anatomical source (fingers, palms and soles) and skin conditions when making value determinations

4.8.1.2. Understand and demonstrate the ability to properly determine correct orientation

4.8.1.3. Understand the effects of substrates, matrices, and processing methods on the appearance of the impression

4.8.1.4. Understand the effects of distortion (i.e. pressure, processing method) on pattern and feature reliability

4.8.1.5. Understand the effect that distortion has on decision-making tolerance

4.8.1.6. Understand and demonstrate the ability to detect "Red Flags", such as double-taps, tonal reversals, ridge disturbances, misaligned ridges, substrate artifacts, forgeries and fabrications and their significance during examinations

4.8.1.7. Understand the assessment of quality, quantity and rarity of features

4.8.1.8. Understand how the above factors affect the determination of suitability (value) for comparison

4.8.1.9. Demonstrate the ability to render suitability (value) determinations

4.8.1.10. Understand the concept of sufficiency as it relates to drawing conclusions

4.8.1.11. Understand and demonstrate how to document observations

4.8.2. Comparison of Two Impressions

4.8.2.1. Understand and demonstrate how to select an effective target group

4.8.2.2. Understand and demonstrate how to assess the discriminability of features

4.8.2.3. Understand and demonstrate the ability to distinguish between an apparent dissimilarity and an actual difference in ridge arrangement

4.8.3. Source Conclusions

4.8.3.1. Understand and demonstrate the ability to properly interpret the quantity, clarity, and rarity of features as well as the correspondence of those features between two impressions to accurately render a conclusion of:

4.8.3.1.1. Source Exclusion

4.8.3.1.2. Support for Different Sources

4.8.3.1.3. Inconclusive/Lacking Support

4.8.3.1.4. Support for Same Sources

4.8.3.1.5. Source Identification

4.8.3.2. Quality Assurance

4.8.3.2.1. Understand the measures that should be taken to properly scrutinize conclusions (e.g. enhanced documentation in complex examinations, attempt to falsify the original conclusions)

4.8.3.2.2. Understand the types of possible verifications: peer review, blind verification, multiple verifiers, group consensus

4.8.3.2.3. Understand the issues that may contribute to false positives and false negatives (e.g. human factors) and safeguards that can help minimize their occurrence.

4.8.4. Recommended Reading

Ashbaugh, D. R. Quantitative-Qualitative Friction Ridge Analysis: An Introduction to Basic and Advanced Ridgeology. Chapter IV – The Identification Process, 87 – 148. CRC Press, Boca Raton, 1999

Black, J. Friction Ridge Examination (Fingerprints): Evaluating the Extent and Scope of "Verification" in Analysis Comparison Evaluation and Verification (ACE-V). In: Wiley Encyclopedia of Forensic Science; Jamieson, A., Moenssens, A., Eds.; John Wiley & Sons Ltd, Chichester, 2009

Maceo, Alice V. *Qualitative Assessment of Skin Deformation – A Pilot Study*. Journal of Forensic Identification. 2009, 59 (4), 390-440

Vanderkolk, John, R. Forensic Comparative Science. Chapter 6 – Analysis, Analysis, Comparison, Evaluation, and Verification, 89 – 102. Elsevier Academic Press, London, 2009

Wertheim, Pat *Detection of Forged and Fabricated Latent Prints*. Journal of Forensic Identification. 1994 44(6), 652-681

4.9. Logic, Probability, and Statistics

A friction ridge examiner conducts examinations of friction ridge evidence which consists of partial, smudged, and incomplete recordings of the raised portion of the epidermis on palmar and plantar skin. The examiner analyzes impressions or other marks to detect relevant details, to compare these details to a reference exemplar, and to evaluate the probability of the

observations under two competing propositions: (1) the two friction-ridge impressions originated from the same source, or (2) the two friction-ridge impressions originated from different sources. The examiner then forms opinions regarding (1) the weight or significance of the correspondence (or lack of correspondence) in the observed details of different marks or (2) which proposition is true. Judgments about weight may be expressed in either qualitative terms or, with the use of a validated model, in quantitative terms. Judgments about the competing propositions are not certainties; they must be accompanied by probabilities of error. This module provides a list of concepts and terms from probability theory and statistics that are applicable to evaluating the weight of evidence and expressing uncertainty in conclusions.

The readings listed at the end of this module are not exhaustive, and other textbooks and online resources cover the same material. Although the readings include mathematical expositions, facility with the mathematics is not the objective. The objective is to ensure the trainee is familiar with the statistical concepts that apply to friction-ridge examinations. At a minimum, the trainee shall understand the following concepts:

4.9.1. Logic and Reasoning

4.9.1.1. Understand how inferences are formed using deductive, inductive, and abductive logic.

4.9.1.2. Understand the different circumstances in which deductive, inductive, and abductive logic are utilized as well as the strengths and limitations associated with these resulting inferences.

4.9.2. Descriptive Statistics

4.9.2.1. Understand the concepts of variables, data, frequency distributions, and statistics.

4.9.2.2. Understand statistics and displays for describing the center and variability of data.

4.9.3. Probability Theory (Model → Data, or Population → Sample)

4.9.3.1. Understand the axioms of mathematical probability and the definition of a probability function.

4.9.3.2. Understand the definition of conditional probability and why transposing the events or propositions in a conditional probability is not generally correct.

4.9.3.3. Understand the difference between a likelihood and a probability.

4.9.3.4. Understand the relationship between probabilities and odds.

4.9.3.5. Understand the components of the odds form of Bayes' rule for binary variables (prior probability, likelihood ratio, posterior probability) and their relationship.

4.9.4. Inferential Statistics (Data → Model, or Sample → Population)

4.9.4.1. Understand the concept of a "probability distribution and its parameters".

4.9.4.2. Understand the difference between a sample statistic and a population parameter, including the estimation of a population proportion from a sample proportion.

4.9.4.3. Understand the concepts of measurement error (including bias and random error), sampling error, and modeling error.

4.9.4.4. Understand and be able to explain the differences between the following conditional probabilities and their use when describing the performance of an analytical technique:

4.9.4.4.1. Sensitivity

4.9.4.4.2. Specificity

4.9.4.4.3. False Positive Rate

4.9.4.4.4. False Negative Rate

4.9.4.4.5. Positive Predictive Value

4.9.4.4.6. Negative Predictive Value

4.9.4.4.7. False Positive Discovery Rate

4.9.4.4.8. False Negative Discovery Rate

4.9.5. Reporting Results

4.9.5.1. Understand the various methods of expressing the weight of evidence as they relate to fingerprint evidence:

4.9.5.1.1. Posterior probability

4.9.5.1.2. Likelihood ratio

4.9.5.1.3. Bayes' Factor

4.9.5.1.4. Conditional Match Probability

4.9.6. Recommended Reading

MIT Open Courseware, Introduction to Probability and Statistics, Massachusetts Institute of Technology, Available online at: http://ocw.mit.edu/courses/mathematics/18-05-introduction-to-probability-and-statistics-spring-2014/readings/

MIT OpenCourse: "Introduction"

MIT OpenCourse: "Probability Terminology and Examples"

MIT OpenCourse: "Variance of Discrete Random Variables"

MIT OpenCourse: "Conditional Probability, Independence and Bayes' Theorem"

MIT OpenCourse: "Introduction to Statistics"

MIT OpenCourse: "Bayesian Updating with Discrete Priors"

MIT OpenCourse: "Bayesian Updating: Probabilistic Prediction"

MIT OpenCourse: "Bayesian Updating: Odds"

Moore, David S., McCabe, George P., and Craig, Bruce A. Introduction to the Practice of Statistics. Chapters 1, 2 and 4, W. H. 9th edition, Macmillan Learning, 2016

Lindley, Dennis V. Understanding Uncertainty (2nd edition). Chapters 1 and 6, Wiley, Hoboken, NJ, 2014

European Network of Forensic Science Institutes (ENFSI) Guideline for Evaluative Reporting in Forensic Science, 2015. Available at: http://enfsi.eu/sites/default/files/documents/external_publications/m1_guideline.pdf

Champod, Christophe et al. Fingerprints and Other Ridge Skin Impressions (2nd Edition). Chapter 4. CRC Press, Boca Raton, 2016.

4.10. Human Factors

Human factors focus on the interactions between humans and products, decisions, procedures, workspaces, and the overall environment encountered in the workplace and daily living. Human factors affect the decision-making process and therefore examiners need to understand how decisions are made as they relate to friction ridge examinations. At a minimum, the trainee shall have a general understanding of the following topics and how they may impact examinations:

4.10.1. Decision Making Process

4.10.1.1. Understand how personal, professional, and societal values, preferences, and other factors impact decision making during friction ridge examinations.

4.10.2. Cognitive Interpretation by the Examiner

4.10.2.1. Understand bias and how it can affect the interpretation of friction ridge skin features and the resulting conclusions.

4.10.2.1.1. Confirmation Bias

4.10.2.1.2. Contextual Bias

4.10.2.2. Understand how directionality of the comparison could affect bias

4.10.3. Condition of the Examiner

4.10.3.1. Understand the effects of fatigue

4.10.3.2. Understand the effects of medication

4.10.3.3. Understand the effects of mental and physical well-being and stress management

4.10.3.4. Understand the effects of vision fluctuations over time

4.10.3.5. Understand the possibility of performance variations

4.10.4. The Work Environment

4.10.4.1. Understand the importance of a functional workspace, such as:

4.10.4.1.1. Ergonomics, e.g. workspaces, desks and chairs

4.10.4.1.2. Lighting

4.10.4.1.3. Computer monitors, keyboards

4.10.4.2. Understand the importance of a comfortable work environment, to include ambient factors, such as:

4.10.4.2.1. Temperature

4.10.4.2.2. Background noise

4.10.4.3. Understand the importance of a properly functioning agency culture relating to performance, such as:

4.10.4.3.1. Corrective Action pressures

4.10.4.3.2. General work attitudes

4.10.4.3.3. Work environment discord

4.10.5. Recommended Reading

Latent Print Examination and Human Factors: Improving the Practice Through a Systems Approach. The National Institute of Standards and Technology. 2012

Busey, T. et al. *The impact of fatigue on latent print examinations as revealed by behavioral and eye gaze testing*. Forensic Science International. 2014

Biedermann, A., Bozza S. and Taroni, F. *Decision theoretic properties of forensic identification: Underlying logic and argumentative implications*. Pages 177, 120-132. Forensic Science International. 2008

4.11. Legal Issues

Forensic science is by definition a field that is applied within the context of the legal system. Thus, many friction ridge examiners who conduct casework are often called upon to testify in a court of law as subject matter experts in their respective forensic discipline. The following training outline will cover various aspects relating to the legal system and the friction ridge examiner's role in this system. The trainee shall demonstrate an understanding of the formalized processes that relate to the expert witness, courtroom etiquette, qualification and admissibility, and any other areas of knowledge that have reasonable potential to be referenced during expert testimony. At a minimum, the trainee shall have a general understanding of the following topics:

4.11.1. General Courtroom Orientation and Etiquette

4.11.1.1. Understand the orientation of the courtroom (typical places for prosecution, defense, judge, witness, jury, stenographer, etc.)

4.11.1.2. Understand the roles and responsibilities of key personnel within the judicial system

4.11.1.3. Understand the importance of verbal and non-verbal communication, e.g. body language and posture

4.11.1.4. Understand the importance of volume and inflection

4.11.1.5. Understand the importance of courtroom demeanor

4.11.1.6. Understand etiquette when addressing the judge

4.11.1.7. Understand the proper way to enter the courtroom and approach the witness stand

4.11.1.8. Understand the rules about witness exclusion from the courtroom and when they apply

4.11.1.9. Understand the jurisdiction's rules about reference to notes or other materials

4.11.1.10. Understand the rules about witness dismissal after testimony

4.11.1.11. Understand how to appropriately react when an objection has been raised

4.11.1.12. Understand the hearsay and confrontation clause

4.11.2. Qualification, Credibility, and Admissibility

4.11.2.1. Understand and demonstrate how to construct a curriculum Vitae (CV)

4.11.2.2. Understand the meaning of voir dire and how to properly respond to qualifying questions

4.11.2.3. Understand and demonstrate how to prepare for and request pre-trial interviews

4.11.2.4. Understand the significance of discovery and disclosure

4.11.2.5. Understand the implications of social media on the credibility of the expert witness

4.11.2.6. Understand how to prepare demonstrative exhibits for trial

4.11.2.7. Understand how evidence and examination results are introduced

4.11.2.8. Understand the differences in testimony types (fact vs. opinion)

4.11.2.9. Understand the significance of education and training

4.11.2.10. Understand the value of professional certifications

4.11.2.11. Understand the significance of accreditation

4.11.2.12. Understand the importance of proficiency testing

4.11.2.13. Understand the significance of laboratory quality assurance processes (Administrative / Technical Review) and other quality control mechanisms

4.11.2.14. Understand the operation of legal admissibility standards, such as:

4.11.2.14.1. Frye Standard

4.11.2.14.2. Federal Rules of Evidence specific to expert testimony

4.11.2.14.3. Daubert Standard

4.11.2.14.4. Other Frye derivatives

4.11.2.14.5. State and local Rules of Evidence

4.11.2.14.6. Understand what learned treatises are

4.11.3. Landmark Court Decisions, e.g.

4.11.3.1. People vs. Jennings (1910)

4.11.3.2. People vs. Crispi (1911)

4.11.3.3. U.S. vs. Frye (1923)

4.11.3.4. People vs. Les (1934)

4.11.3.5. Commonwealth vs. Bartolini (1938)

4.11.3.6. Daubert Trilogy: Daubert vs. Merrell Dow Pharmaceuticals (1993); General Electric vs. Joiner (1997); Kumho Tire vs. Carmichael (1999)

4.11.3.7. U.S. vs. Mitchell (1999)

4.11.3.8. U.S. vs. Llera-Plaza I and II (2002)

4.11.3.9. Commonwealth of MA v. Patterson (2005)

4.11.3.10. New Hampshire vs. Richard Langill (2008)

4.11.3.11. U.S. vs. Brian Keith Rose (2010)

4.11.4. Notable Errors in Fingerprint-Related Cases, e.g.

4.11.4.1. John Orr (1991)

4.11.4.2. Shirley Mckie (1999)

4.11.4.3. Mark Miller (2001)

4.11.4.4. Brandon Mayfield (2004)

4.11.4.5. Dexter Presnell (2005)

4.11.4.6. Lana Canen (2012)

4.11.4.7. Alton Dandridge (2015)

4.11.5. Forgery / Fabrication Cases, e.g.

4.11.5.1. William DePalma - Fabrication (1967)

4.11.5.2. Herman Wiggins - Fabrication (1970's)

4.11.5.3. NY State Troop "C" – Fabrication (1989)

4.11.5.4. Frederik van der Vyver – Fabrication (2005)

4.11.5.5. Peter Paul Biro – Jackson Pollack fake - Forgery (2008)

4.11.6. Courtroom Testimony: Effectively articulating in a court of law, the following items and their association to friction ridge examination:

4.11.6.1. Describe the difference between error rate types:

4.11.6.1.1. False positives / Type I

4.11.6.1.2. False negatives / Type II

4.11.6.2. Describe how human factors can affect decision-making

4.11.6.3. Describe different types of Biases that can occur during friction ridge comparisons

4.11.6.4. Describe the difference between verification and blind verification

4.11.6.5. Describe the examination process

4.11.6.6. Describe the importance of chain of custody integrity

4.11.6.7. Describe the differences between sufficiency for collection, sufficiency for comparison, and sufficiency for conclusion

4.11.6.8. Describe the strengths and weaknesses of ACE-V

4.11.6.9. Describe the research that supports why a point standard is inappropriate

4.11.6.10. Describe how tolerance is established for differences in appearance during analysis

4.11.6.11. Describe the research that measures the rarity of friction ridge detail

4.11.6.12. Describe how likelihood ratio research is used to support conclusions

4.11.6.13. Describe the importance of accreditation and certification

4.11.6.14. Describe the difference between accuracy and reliability

4.11.6.15. Describe quality assurance measures that can be implemented to reduce errors and mitigate bias

4.11.6.16. Describe the difference between objectivity and subjectivity

4.11.6.17. Describe the importance of examination process standards

4.11.6.18. Describe the importance of objective testimony; avoiding bolstering or exaggerating what is demonstrable

4.11.6.19. Describe the difference between two dimensional and three-dimensional friction ridge detail and how it relates to sufficiency

4.11.6.20. Describe the research that studies the persistence of friction ridge detail

4.11.6.21. Describe the effect of quality and quantity on the utility of a print

4.11.6.22. Describe the research that assesses the discriminability of feature configurations

4.11.6.23. Describe the latent print suitability research for database searches

4.11.6.24. Describe the research that assesses the reproducibility and repeatability of latent print examiner conclusions

4.11.7. Scientific Studies and Research: related literature that covers a diverse scope of friction ridge related topics that have been challenged in the court system: it is the

trainer and trainees' responsibility to stay abreast of novel and significant research. This can be accomplished through professional associations, peer-reviewed journals that are part of generally available scientific literature and published texts.

4.11.8. Mock Trial Program: The trainee shall demonstrate their training in the form of expert testimony. The mock trial program should simulate the courtroom to include the roles of the prosecution and the defense. This simulation shall include all aspects of testimony that the examiner would expect to encounter. Multiple mock trials are recommended in a graduated difficulty format. The mock trial(s) shall include a formal evaluation of the trainee's readiness to testify in a court of law.

4.11.8.1. Example Mock Trial Program:

4.11.8.1.1. Mock Trial #1: Focus on basic qualifying questions

4.11.8.1.2. Mock Trial #2: Qualifying questions; introduce cross-examination (defense)

4.11.8.1.3. Mock Trial #3: Qualifying questions; challenging direct and cross examination

4.11.8.1.4. Mock Trial #4: Final: Aggressive direct and cross examination; challenging topics; admissibility related topics

4.11.9. Recommended Reading:

Moenssens, Andre A., Meagher, Stephen B. The Fingerprint Sourcebook. Chapter 13 – *Fingerprints and the Law.* National Institute of Justice. 2011

Chisum, Jerry, W., Turvey, Brent E., Crime Reconstruction. Chapter 13 – *Surviving and Thriving in the Courtroom,* 483-506. Elsevier Academic Press. 2007

National Academy of Sciences. Strengthening Forensic Science in the United States: A Path Forward. Pages 1-53, 136-145. National Research Council. 2009

Wertheim, P. *Detection of Forged and Fabricated Latent Prints*. Journal of Forensic Identification 44(6) 652, 1994

Steele, Lisa J. *The Defense Challenge to Fingerprints*. Criminal Law Bulletin 40(3), 213-240. 2004

Edmond, Gary, et al. *A guide to interpreting forensic testimony: Scientific approaches to fingerprint evidence*. Law, Probability & Risk. 13(1): 1-25. Oxford Academic. 2013

Executive Office of the President, President's Council of Advisors on Science and Technology (PCAST), Panel on Forensic Science, *Forensic Science in Criminal Courts: Ensuring Scientific Validity of Feature-Comparison Methods*, September 2016.

Executive Office of the President, President's Council of Advisors on Science and Technology (PCAST), Panel on Forensic Science, *Forensic Science in Criminal Courts: Ensuring Scientific Validity of Feature-Comparison Methods;* Addendum to 1st edition September 2016, January 2017.

4.12. Automated Biometric Identification System (ABIS)

An automated biometric identification system is a computer-based system for reading, cataloguing, searching, matching, and storing friction ridge images, feature templates and related text data; typically comprised of feature extraction, matching, and decision-logic subsystems. It is a tool that many agencies utilize to search unknown friction ridge impressions to generate potential comparison candidates. The following training outline will cover various aspects relating to the utility and application of these automated systems.

Prior to automation training, friction ridge examiners must possess the knowledge, skills, and ability to recognize comparable friction ridge detail.

Given the ubiquity of ABIS, all trainees should have a general familiarity of the system while those trainees who will eventually perform work on an ABIS will be required, at minimum, to have a general understanding of the following topics:

4.12.1. Image Acquisition

4.12.1.1. Describe types of friction ridge recordings (e.g., rolled, flat, simultaneous, palm, and supplemental impressions)

4.12.1.2. Describe methods of friction ridge capture (e.g., ink and livescan)

4.12.1.3. Describe types of capture devices (e.g., livescan, flatbed scanner, and camera)

4.12.1.4. Understand point of capture variables (e.g., condition of fingers, condition of platen, rolling speed, ink volume, and movement)

4.12.1.5. Understand control measures needed to achieve quality friction ridge images (e.g., scan resolution, compression rate, equipment maintenance, and calibration)

4.12.1.6. Understand procedures for addressing amputations, temporary injuries, skin conditions, rescans

4.12.1.7. Understand individual agency livescan operator training policies

4.12.2. Function and Use of ABIS

4.12.2.1. Understand ABIS processes related to acquisition, classification, searching, storage, retrieval, identification, and final reporting of friction ridge records

4.12.2.2. Understand composite records

4.12.2.3. Describe friction ridge search criteria (e.g., designated finger search, how many fingers, and palm areas)

4.12.2.4. Understand system quality controls, which ensure completeness, image quality, and data integrity

4.12.2.5. Understand individual agency system user guides

4.12.2.6. Describe system tolerance for image rotation

4.12.2.7. Understand minutiae extraction, minutiae matching, placement, rotation, ridge counts, and other minutiae factors related to searching and matching

4.12.2.8. Understand system interoperability.

4.12.2.8.1. Understand extended Feature Set (EFS) image and feature search profiles, as described in detail in the NIST Special Publication 1151, Markup Instructions for Extended Feature Sets.

4.12.2.8.2. Understand ANSI NIST record types (Type-1, Type-2, Type-4, Type-9, Type-13, Type-14, Type-15)

4.12.2.9. Understand integration of friction ridge images and personal descriptors

4.12.2.10. Understand significance in the range of candidate scores, threshold scoring, and candidate list and associated scores

4.12.2.11. Understand balancing system and personnel resources for optimal accuracy, timeliness, and thoroughness

4.12.2.12. Understand search capabilities relating to latent print versus tenprint, tenprint versus latent print, latent print versus latent print, tenprint versus tenprint, and palmprint versus palmprint.

4.12.2.13. Understand “lights out” processing of searches

4.12.2.14. Understand logical search progression (i.e., local ABIS first, then state,

regional, national, and international).

4.12.2.15. Describe benefits and risks to using search parameters to limit database penetration (e.g., finger position, sex, pattern classification and referencing, race, offense, and geographic location).

4.12.2.16. Describe search result contents (e.g., ranked order, unique identifier, and finger or palm position).

4.12.2.17. Understand image properties and compression issues (e.g., potential loss of quality due to compression of images, monitor resolution, and capture resolution).

4.12.2.18. Understand printer technology limitations versus examinations from digital images (e.g., quality degradation of printed images)

4.12.2.19. AFIS processes related to latent print searches

4.12.2.19.1. Describe manual and automatic encoding of minutiae

4.12.2.19.2. Understand record authentication processes (e.g., correct association of name, unique identifier, and friction ridge images)

4.12.3. Recommended Reading:

ANSI/NIST-ITL 1-2011 Update: 2015, Data Format for the Interchange of Fingerprint & other Biometric Information, NIST Special Publication 500-290e3, National Institute of Standards and Technology, Washington, DC, 2015.

Criminal Justice Information Services, Electronic Biometric Transmission Specification (EBTS), version 10.0, Federal Bureau of Investigation, Clarksburg, WV, 2013.

Ken Moses, Chapter 6: Automatic Fingerprint Identification Systems (AFIS), in: A. McRoberts (Ed.) The Fingerprint Sourcebook, National Institute of Justice, Washington D.C., 2011, pp. 6-1 - 6-33.

Will Chapman, Austin Hicklin, George I. Kiebuzinski, Peter Komarinski, John Mayer-Splain, Melissa Taylor, Rachel Wallner, Latent Interoperability Transmission Specification, NIST Special Publication 1152, National Institute of Standards and Technology, Washington, DC, 2013.

Will Chapman, Austin Hicklin, George I. Kiebuzinski, Peter Komarinski, John Mayer-Splain, Melissa Taylor, Rachel Wallner, Markup Instructions for Extended Friction Ridge Features, NIST Special Publication 1151, National Institute of Standards and Technology, Washington, DC, 2013.

Peter Komarinski, Automated Fingerprint Identification Systems (AFIS), Elsevier Academic Press, New York, 2005.

Thomas Busey, Arch Silapiruti, John Vanderkolk, The relation between sensitivity, similar non-matches and database size in fingerprint database searches. Law, Probability, and Risk (2014) 13, 151-168.

5. Appendix A: Change Log

Version	Date	Change
1.0	12/22/2017	Original Issue