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Standard for Friction Ridge Examination Training Program

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410 North 21st Street
Colorado Springs, CO 80904

Foreword

The criminal justice system depends on friction examiners to perform their work productively and in ways that render reliable and uniform outcomes. This means examiners should be well trained in established scientific methods, procedures and protocols regarding the overall handling and interpretation of friction ridge evidence.

The American Academy of Forensic Sciences established the Academy Standards Board (ASB) in 2015 with a vision of safeguarding Justice, Integrity and Fairness through Consensus Based American National Standards. To that end, the ASB develops consensus based forensic standards within a framework accredited by the American National Standards Institute (ANSI), and provides training to support those standards. ASB values integrity, scientific rigor, openness, due process, collaboration, excellence, diversity and inclusion. ASB is dedicated to developing and making freely accessible the highest quality documentary forensic science consensus Standards, Guidelines, Best Practices, and Technical Reports in a wide range of forensic science disciplines as a service to forensic practitioners and the legal system.

This document was revised, prepared, and finalized as a standard by the Friction Ridge Consensus Body of the AAFS Standards Board. The draft of this standard was developed by the Physics/Pattern Interpretation Subcommittee of the Organization of Scientific Area Committees (OSAC) for Forensic Science.

Questions, comments, and suggestions for the improvement of this document can be sent to AAFS-ASB Secretariat, asb@aafs.org or 401 N 21st Street, Colorado Springs, CO 80904.

All hyperlinks and web addresses shown in this document are current as of the publication date of this standard.

ASB procedures are publicly available, free of cost, at www.aafs.org/academy-standards-board.

Keywords: *TBD*

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Standard for Friction Ridge Examination Training Program

1 Scope

This document provides the requirements for a forensic service provider's (FSP's) training program for friction ridge examiners and includes ~~recommended~~ learning outcomes for the trainee. This document does not provide lesson plans, practical exercises, or performance measures for successful completion of each module. Individual sections only apply to trainees who perform those job functions.

2 Normative References

The following references are documents that are indispensable for the application of the standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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*, 2016

Expert Working Group on Human Factors in the Analysis of Latent Prints. *Latent Print Examination and Human Factors: Improving Practice through a Systems Approach*. National Institute of Standards and Technology, 2012

3 Terms and Definitions

For purposes of this document, the following definitions apply.

3.1
competent friction ridge examiner (refer to examiner -friction ridge)
An individual who has successfully completed their FSP's training program and has demonstrated to the FSP that they possess the knowledge, skills, and abilities to perform the tasks required of their current position.

3.2
examiner (friction ridge)
An individual authorized to conduct independent friction ridge examinations for the forensic service provider by observing and interpreting data, making decisions, forming conclusions and opinions, issuing reports and/or providing testimony. Use of the term "*examiner*" in these documents refers to a "*competent friction ridge examiner*" and not a "*trainee.*"

~~3.1~~3.3 exemplar prints
Intentional recordings of friction ridge skin for the purpose of forensic comparison and/or identification.

~~**1.1**~~
~~**FSP**~~
~~Forensic service provider.~~

~~**1.2**~~
~~**macroscopic features**~~
~~Characteristics of an impression that can be generally observed without magnification, such as overall impression shape, ridge flow, pattern type, flexion creases, etc.~~

~~**1.3**~~
~~**microscopic features**~~
~~Characteristics of an impression that generally require magnification, such as ridge path, ridge edges, pores, etc.~~

3.4
forensic service provider
FSP
A forensic science entity or forensic science practitioner providing forensic science services.

3.5
friction ridge features
The combination of ridge flow, ridge characteristics, and ridge structure of friction ridge skin, as reproduced and observed in an impression. The observed data used to compare and interpret similarity or dissimilarity between impressions.

3.6
observed data
Any information seen within an impression that an examiner relies upon to reach a decision, conclusion, or opinion. This not only includes minutiae, but attributes such as clarity, scars, creases, edge shapes, pore structure, and other friction ridge features.

3.7
trainee
An individual not yet authorized to conduct independent friction ridge examinations for the FSP; usually still in training.

4 Levels of Comprehension and Learning Outcomes

4.1 General

The learning outcomes reflect the level of comprehension the trainee is expected to achieve for each topic. In other words, the learning outcomes include both what the trainee should know and what the trainee should be able to do. For this document, four levels of comprehension are defined. These levels of comprehension are derived from Bloom's Taxonomy which is described further in Annex A: Remember, Understand, Demonstrate, and Integrate.

4.2 Remember

Learning outcomes at the "Remember" level require/recommend the trainee to retrieve the relevant information from long-term memory. Learning outcomes for this level of comprehension contain the following keywords: define, identify, indicate, list, recall, recite, and recognize.

4.3 Understand

Learning outcomes at the "Understand" level require/recommend the trainee to construct meaning from the information presented. Learning outcomes for this level of comprehension contain the following keywords: describe, discuss, explain, and summarize.

4.4 Demonstrate

Learning outcomes at the "Demonstrate" level require/recommend the trainee to understand the overall structure and purpose of the information they have learned and apply this information in ~~novel circumstances.~~exhibition and explanation. Learning outcomes for this level of comprehension contain the following keywords: apply, articulate, assign, categorize, check, collect, communicate, compare, contrast, declare, demonstrate, detect, determine, display, distinguish, document, exclude, exploit, follow, include, indicate, interpret, maintain, operate, prepare, respond, search, and select.

4.5 Integrate

Learning outcomes at the "Integrate" level require/recommend the trainee to assimilate information from multiple sources to predict arguments, evaluate strengths and weaknesses, and justify opinions. Learning outcomes for this level of comprehension contain the following keywords: assess, anticipate, consider, debate, evaluate, formulate, predict, relate, support, and weigh.

5 Qualifications

5.1 Trainee

~~A new trainee to the discipline shall have a Bachelor's degree from an accredited institution. At the time of hiring, the trainee shall have 24 semester hours (or equivalent) in Science, Technology, Engineering or Mathematics (STEM) related coursework. This requirement shall be effective 18 months after the official publication of this document.~~

~~NOTE A degree in a natural or physical science is highly recommended.~~

All friction ridge examiners shall have successfully completed training prior to conducting independent friction ridge examinations according to FSP policy.

5.2 Instructors and Mentors

Instructors and mentors shall have acquired ~~and maintained proficiency for a~~ the minimum ~~of one year in the topic areas they instruct.~~competencies themselves. Each FSP shall have a written policy for selecting qualified instructors and mentors. Instructors and mentors shall provide lectures and demonstration of the materials and skills trainees are expected to learn.

NOTE A certified Instructor's Development course is ~~highly~~ recommended.

6 Performance Measures and Training Records

The FSP shall have a policy to define passing criteria for all written, practical, and verbal assessments. A training record of these assessments shall be maintained by the FSP for as long as the individual is employed as a friction ridge examiner. Ultimately, the trainee shall be able to

demonstrate their ability to communicate their FSP casework practices, the foundation of the friction ridge discipline, and the basis for conclusions to the trier of fact by participating in a mock trial (~~See Section~~see 7.~~13~~12.6).

7 Training Modules

7.1 General

The training program sub-topics and the trainee learning outcomes are described for each module. Individual sections shall only apply to trainees ~~who's~~whose tasks require the performance of those job functions. The learning outcomes listed should be achieved by the trainee by the completion of the FSP's training program. After the completion of the training program the trainee shall become a friction ridge examiner (bench level analyst). The bibliography in Annex A provides source material for each module. The time for a trainee to complete the training program shall be defined by individual FSP policy.

7.2 Friction Ridge Skin

7.2.1 Features on the Surface of the Friction Ridge Skin

The training program shall include an exploration of the common friction ridge features found on ~~healthy~~ friction ridge skin. This exploration shall include the robustness of the features (three-dimensional attributes) and the expected reproducibility (recordability) of those features when the skin contacts a surface. These features include: ridges, furrows, patterns, cores, deltas, flexion creases, secondary creases, wrinkles, and incipient ridges.

7.2.1.1 The trainee shall be able to indicate pattern regions in the friction ridge skin, including cores and deltas.

7.2.1.2 The trainee shall be able to identify the flexion creases in the friction ridge skin of the hands and feet.

7.2.1.3 The trainee shall be able to ~~predict~~ describe how flexion creases should record when the skin contacts a surface.

7.2.1.4 The trainee shall be able to identify ridges and furrows in the friction ridge skin.

7.2.1.5 The trainee shall be able to ~~predict~~ describe how ridges and furrows should record when the skin contacts a surface.

7.2.1.6 The trainee ~~shall~~should be able to identify incipient ridges in the friction ridge skin.

7.2.1.7 The trainee shall be able to describe factors that affect the reproducibility of incipient ridges when the skin contacts a surface.

7.2.1.8 The trainee shall be able to identify secondary creases and wrinkles in the friction ridge skin.

7.2.1.9 The trainee shall be able to describe factors that affect the reproducibility of secondary creases and wrinkles when the skin contacts a surface.

7.2.2 Categorization and Use of Features on the Surface of the Friction Ridge Skin

The training program shall introduce the categorization of friction ridge features ~~as macroscopic and microscopic~~ and the significance of the ~~macroscopic and microscopic information~~observed data during the examination process.

~~Macroscopic features shall include: shape of the hands and feet (size and contours), classification patterns (i.e., arch, loop, and whorl), deltas (existence, number, position, and shape), regionally distinct ridge flows, flexion creases (existence, position, and path), scars (existence, position, and path), secondary creases and wrinkles (existence, position, path, and density), occasional features (existence, position, and path) and relationships between macroscopic features (ridge counts, distances, and angles).~~

~~Microscopic features shall include: ridge paths (location, direction, length, width, and curvature), minutiae (location and direction), incipient ridges (location, direction, length, width, and morphology), ridge morphology (edge shapes, texture, and pore positions), flexion crease morphology, scar morphology, occasional feature morphology), relationships between microscopic features (ridge counts, distances and angles), and relationships between microscopic and macroscopic features (ridge counts, distances and angles).~~

7.2.2.1 The trainee shall be able to list the ~~macroscopic~~ features of the friction ridge skin.

~~**1.3.1.1** The trainee shall be able to list the microscopic features of the friction ridge skin.~~

7.2.2.2 The trainee shall be able to explain why ~~macroscopic~~ friction ridge features can be used to establish the anatomical region and distal orientation of hands and feet.

~~**1.3.1.2** The trainee shall be able to explain why macroscopic features of the hands and feet can be used to include or exclude subjects from an unknown (questioned) print.~~

7.2.2.3 ~~The trainee shall be able to explain why microscopic~~ friction ridge features of the hands and feet can be used to include or exclude subjects from an unknown (questioned) print.

7.2.3 General Anatomy of the Friction Ridge Skin

The training program shall include the general anatomy of the friction ridge skin to include the following concepts: epidermis, dermis, basement membrane, hypodermis, primary ridges, secondary ridges, keratin, keratinocyte, melanocyte, leukocyte, dermal papilla, sweat glands and ~~merkel~~Merkel cells.

7.2.3.1 The trainee shall be able to identify epidermis, dermis and hypodermis of the friction ridge skin.

7.2.3.2 The trainee shall be able to describe the primary functions of the epidermis, dermis and hypodermis.

7.2.3.3 The trainee shall be able to identify primary and secondary ridges of the friction ridge skin.

7.2.3.4 The trainee shall be able to explain the relationship between the primary ridges and the surface ridges.

7.2.3.5 The trainee shall be able to explain the relationship between the secondary ridges and the surface furrows.

7.2.3.6 The trainee shall be able to explain the significance of the dermal papilla as a support structure for the skin.

7.2.3.7 The trainee shall be able to explain the significance of the basement membrane as an attachment site between the epidermis and dermis.

7.2.3.8 The trainee shall be able to describe the general structure and function of sweat glands in the friction ridge skin.

7.2.3.9 The trainee should be able to list the main cell types found in the epidermis of the friction ridge skin and the primary function of each cell type.

7.2.3.10 The trainee should be able to describe keratin and explain the importance of keratin distribution in the friction ridge skin.

7.2.3.11 The trainee shall be able to support the ~~theory of~~ persistency of the arrangements of the mature friction ridge features with the physical connections within the friction ridge skin that stabilize the positions of the features in friction ridge skin.

7.2.3.12 The trainee should be able to relate the importance of the banding of Merkel cells in the pre-patterning of primary ridge formation.

7.2.4 General Physiology of the Friction Ridge Skin

The training program shall include the general physiological processes within the friction ridge skin to include the following concepts: keratinocyte mitosis, transient amplifying cells, layers of the epidermis, differentiation of the keratinocytes, and regulation of cell mitosis.

7.2.4.1 The trainee shall be able to identify the five layers of the epidermis in the friction ridge skin.

7.2.4.2 The trainee should be able to describe the sequence of changes that take place as keratinocytes differentiate.

7.2.4.3 The trainee should be able to discuss the importance of the transient amplifying cells in maintaining the three-dimensional height of the surface ridges.

7.2.4.4 The trainee should be able to explain the major pathways for regulating basal keratinocyte mitosis.

7.2.4.5 The trainee shall be able to support ~~the theory of~~ persistency of the arrangements of the mature friction ridge features. This should include the ability to describe the physiological processes within the friction ridge skin that regulate basal keratinocyte mitosis and stabilize the robustness of the features.

7.2.5 Wound Healing in the Friction Ridge Skin

The training program shall include the skin's response to an injury, the appearance of healing skin, the formation of scars, and the appearance of scars.

7.2.5.1 The trainee shall be able to summarize the basic process of wound healing in the skin.

7.2.5.2 The trainee should be able to explain the possible outcomes of healing skin (e.g., no scar, visible scar, or invisible scar) and why these different outcomes arise.

7.2.5.3 The trainee should be able to identify healing skin in impressions of friction ridge skin.

7.2.5.4 The trainee should be able to describe the attributes that support the determination of actively healing skin.

7.2.5.5 The trainee shall be able to discuss the expected reproducibility of the attributes of healing friction ridge skin.

7.2.5.6 The trainee shall be able to identify scars in impressions of friction ridge skin.

7.2.5.7 The trainee shall be able to describe the attributes that support the assignment of "scar" to the feature.

7.2.5.8 The trainee shall be able to compare impressions taken from the same friction ridge skin pre-scar and post-scar.

7.2.5.9 The trainee shall be able to assess the changes in arrangements of the mature friction ridge features in pre-scar and post-scar impressions of the friction ridge skin.

7.2.6 Aging of the Friction Ridge Skin

The training program shall include the expected changes that take place in the friction ridge skin as a person grows to adulthood and as an adult reaches later decades of life.

7.2.6.1 The trainee should be able to describe why foot and hand growth during adolescence disproportionately increases the length and width friction ridges and furrows.

7.2.6.2 The trainee shall be able to recognize through a comparison of known exemplars the three common characteristics of impressions of late age friction ridge skin: flattened ridges, increased number of wrinkles, and increased prominence of incipient ridges.

7.2.6.3 The trainee should be able to explain why ridges tend to flatten in late-age friction ridge skin.

7.2.6.4 The trainee should be able to explain why wrinkles tend to increase in number in late-age friction ridge skin.

7.2.6.5 The trainee should be able to explain why incipient ridges tend to become more prominent in late-age friction ridge skin.

7.2.6.6 The trainee shall be able to compare impressions taken from the same friction ridge skin decades apart.

7.2.6.7 The trainee shall be able to assess the changes that have occurred with age in friction ridge impressions taken decades apart.

7.2.7 Common Disorders of the Friction Ridge Skin

The training program shall introduce common disorders of the friction ridge skin. At a minimum, this shall include psoriasis and epidermal warts and should introduce dissociated ridges, displaysia, split ridges, and smoothing of friction ridges due to chemotherapy drug administration.

7.2.7.1 The trainee should be able to identify psoriasis in impressions of friction ridge skin.

7.2.7.2 The trainee should be able to describe the attributes that support the determination of psoriasis.

7.2.7.3 The trainee should be able to discuss the expected reproducibility of the attributes of psoriasis in impressions of the friction ridge skin.

7.2.7.4 The trainee should be able to identify warts in impressions of friction ridge skin.

7.2.7.5 The trainee should be able to describe the attributes that support the assignment of "wart" to a feature.

7.2.7.6 The trainee should be able to discuss the expected reproducibility of the attributes of warts in impressions of the friction ridge skin.

7.2.7.7 The trainee should also be able to identify the presence of the following conditions in friction ridge skin and discuss their expected reproducibility in impressions: dissociated ridges, displaysia, split ridges, and smoothing of friction ridges due to chemotherapy drug administration.

7.2.8 Embryological Development of the Hands and Feet

The training program shall include the basic embryological development of the hands and feet to include: development of the hand and foot paddles, formation of the digits, formation of the volar pads, and the formation of the flexion creases. The training program shall include sufficient information about developmental biology to support the learning outcomes for this topic.

7.2.8.1 The trainee shall be able to recite the sequence and timing of the embryological formation of the hand and foot paddles.

7.2.8.2 The trainee shall be able to recite the process of the formation of the digits on the hands and feet.

7.2.8.3 The trainee shall be able to define "volar pads" and identify the standard volar pad locations in the hands and feet.

7.2.8.4 The trainee shall be able to recite the sequence and timing of volar pad formation on the hands and feet.

7.2.8.5 The trainee shall be able to recite the sequence and timing of volar pad regression on the hands and feet.

7.2.8.6 The trainee shall be able to recite the sequence and timing of flexion crease formation on the hands and feet.

7.2.8.7 The trainee shall be able to explain how the overall development of the hands and feet, volar pads, and flexion creases impart variable growth stresses across the volar surfaces.

7.2.9 Embryological Development of the Friction Ridge Skin

The training program shall include the morphogenesis of the fiction ridges and furrows and the impact of variable growth stresses on the ridge flows and patterns found on the friction ridge skin. The training program shall include sufficient information about developmental biology to support the learning outcomes for this topic.

7.2.9.1 The trainee should be able to describe the morphogenesis of the primary ridges including the patterning of the capillary beds and free nerve endings in the dermis and the organization of the Merkel cells into bands in the epidermis prior to primary ridge formation.

7.2.9.2 The trainee should be able to recite the sequence of regional development of the primary ridges in the friction ridge skin.

7.2.9.3 The trainee should be able to assess the relationships between the volar pads and timing of primary ridge development with different pattern types and different ridge counts.

7.2.9.4 The trainee should be able to assess the relationships between major ridges flows in the friction ridge skin with the overall hand and foot growth and presence of flexion creases.

7.2.9.5 The trainee should be able to explain the development of additional primary ridges and minutia as the primary ridges proliferate across the surface of the developing friction ridge skin.

7.2.9.6 The trainee should be able to recite the sequence of regional development of the secondary ridges in the friction ridge skin.

7.2.9.7 The trainee should be able to describe the maturation of the surface ridges, furrows, and sweat glands.

7.2.10 Developmental Noise, Developmental Stability, and Fluctuating Asymmetry

The training program ~~shall~~should include the impact of developmental stability, fluctuating asymmetry, and developmental noise on the embryological growth of the hands, feet, and friction ridge skin. The training program ~~shall~~should include sufficient information about genetics and developmental biology to support the learning outcomes for this topic.

7.2.10.1 The trainee ~~shall~~should be able to define genotype and phenotype.

7.2.10.2 The trainee ~~shall~~should be able to explain the differences between genotype and phenotype.

7.2.10.3 The trainee should be able to explain ontogenetic variability.

7.2.10.4 The trainee should be able to explain inherent developmental variation.

7.2.10.5 The trainee should be able to explain developmental stability and developmental noise.

7.2.10.6 The trainee should be able to explain the relationship between inherent developmental variation and developmental noise.

7.2.10.7 The trainee should be able to explain the impact of genotype, environment, and developmental noise on a phenotype.

7.2.10.8 The trainee should be able to explain fluctuating asymmetry.

7.2.10.9 The trainee should be able to describe the relationship between fluctuating asymmetry and developmental noise.

7.2.10.10 The trainee should be able to ~~relate~~assess observed similarities in patterns and ridge counts on the opposite fingers of the same person with the concept of developmental stability.

7.2.10.11 The trainee should be able to ~~relate~~assess observed ~~differences~~dissimilarities in patterns and ridge counts on the opposite fingers of the same person with the concepts of fluctuating asymmetry and developmental noise.

7.2.10.12 The trainee ~~shall~~should be able to support the discriminating power of the arrangements of the mature friction ridge features and ~~should include articulation of~~articulate the concepts of inherent developmental variation, fluctuating asymmetry, and developmental noise.

7.3 Empirical Observations and Research

7.3.1 History

The training program shall include historical observations regarding the use of friction ridge impressions. This history shall cover the earliest uses in Asia, Europe, South America, and ~~the United States.~~North America

7.3.1.1 The trainee shall be able to recall the circumstances of the earliest known uses of friction ridges impressions as a means of identification in China, Japan, and India.

7.3.1.2 The trainee shall be able to list ~~the following~~ pioneering practitioners and their contributions to the use of friction ridge impressions, for example: Alphonse Bertillon, Edmond Locard, William Hershel, Azizul Haque, Chandra Bose, Edward Richard Henry, Juan Vucetich, Nehemiah Grew, Francis Galton, Henry Faulds, Henry DeForest, Mary Holland, Harold Cummins, John Dondero, Roy Huber, and David Ashbaugh.

7.3.1.3 The trainee shall be able to recall the basic circumstances of the following historical events that further established the use of friction ridge impressions as a means of identification: 1904 World's Fair, Will/William West Case, The Belper Committee, The ~~Troupe~~Troup Committee, and the establishment of the FBI Identification Division.

7.3.1.4 The trainee shall be able to support the current use of friction ridge impressions as a means of personal identification in civil and criminal applications with the history of empirical observations.

7.3.2 Introduction to Fingerprint Classification Systems

The training program ~~shall~~should include the developers and basic elements of the following classification systems: Johannes Purkinje's nine pattern classification, Syllabic System (Henry Faulds), Bertillon System of Anthropometry (Alphonse Bertillon), Tripartite Fingerprint Classification System (Francis Galton), Argentinian Fingerprint Classification System (Juan Vucetich), Henry Classification System (Azizul Haque, Chandra Bose and Edward Richard Henry), and National Crime Information Center (NCIC) Classification System (Federal Bureau of Investigation).

7.3.2.1 The trainee should be able to recall the developers and basic elements of the classification systems listed in 7.3.2.

7.3.2.2 The trainee should be able to discuss the significance and relationships of the classification systems listed in 7.3.2.

7.3.2.3 The trainee should be able to consider the challenges with developing and implementing classification systems.

7.3.3 Professional Organizations

The training program should include empirical observations and opinions published by the International Association for Identification~~.~~ (IAI), as well as SWGFAST (Scientific Working Group on Friction Ridge Analysis, Study and Technology), OSAC (Organization of Scientific Area Committees for Forensic Science), AAAS (American Association for the Advancement of Science), PCAST (President's Council of Advisors on Science and Technology), NAS (National Academy of Sciences), NCFS (National Commission on Forensic Science), and AAFS (American Academy of Forensic Science).

7.3.3.1 The trainee should be able to recall the purpose and findings of the International Association for Identification Standardization Committee.

7.3.3.2 The trainee ~~shall~~should be able to recall the purpose and findings of the International Association for Identification Standardization II Committee.

7.3.3.3 The trainee ~~shall~~should be able to recall the International Association for Identification's opinion on requiring a pre-determined number of features for the identification of a friction ridge impression.

7.3.3.4 The trainee ~~shall~~should be able to summarize the progression of the International Association for Identification's opinion on probabilistic testimony and the use of statistical models.

~~**1.3.1.3**~~ The trainee ~~shall~~should be able to recall the purpose and scope of ~~the~~organizations such as: Organization of Scientific Area ~~Communities~~Committees (OSAC~~).~~

7.3.3.5 ~~The trainee shall be able to recall the purpose and scope of the~~) for Forensic Science, AAFS ~~Academy~~ Standards Board (ASB~~).~~), NAS, and PCAST.

7.3.4 Twin Fingerprints

The training program shall include significant findings regarding patterns, ridge counts, and minutia from published research concerning friction ridge impressions from twins.

7.3.4.1 The trainee ~~shall~~should be able to recall the percentage of monozygotic twins, dizygotic twins, and unrelated individuals that share the same pattern on the same finger.

7.3.4.2 The trainee ~~shall~~should be able to compare different study designs and articulate reasons for variation in the findings with respect to the percentage of monozygotic twins, dizygotic twins, and unrelated individuals that share the same pattern on the same finger.

7.3.4.3 The trainee ~~shall~~should be able to recall the percentage of monozygotic twins, dizygotic twins, and unrelated individuals that share the same ridge count on the same finger.

7.3.4.4 The trainee ~~shall~~should be able to compare different study designs and articulate reasons for variation in the findings with respect to the percentage of monozygotic twins, dizygotic twins, and unrelated individuals that share the same ridge count on the same finger.

7.3.4.5 The trainee ~~shall~~should be able to discuss the overall findings of the similarities and differences in minutia between monozygotic twins and non-twins.

7.3.4.6 The trainee ~~shall~~should be able to explain the following concepts from biometric studies: False Acceptance Rate, False Rejection Rate, and Equal Error Rate.

7.3.4.7 The trainee ~~shall~~should be able to describe the impact of twins on the False Acceptance Rate, False Rejection Rate, and Equal Error Rate in some biometric applications.

7.3.4.8 The trainee ~~shall~~should be able to support the observed similarities in patterns and ridge counts on the same fingers of monozygotic twins with the concept of developmental stability.

7.3.4.9 The trainee ~~shall~~should be able to support the observed ~~differences~~dissimilarities in patterns and ridge counts on the same fingers of monozygotic twins with the concept of developmental noise.

7.3.4.10 The trainee ~~shall~~should be able to support the use of friction ridge impressions as a means of personal identification in civil and criminal applications with findings from published twin research.

7.3.5 Fingerprint Pattern Distribution and Fingerprint Minutiae Distribution

The training program shall include published research on the distribution of patterns on the fingers and the distribution of minutiae in fingerprints.

7.3.5.1 The trainee shall be able to describe the variation in pattern frequency by finger.

7.3.5.2 The trainee shall be able to describe the variation in ridge count by finger.

7.3.5.3 The trainee shall be able to describe the variation in minutiae count by finger.

7.3.5.4 The trainee shall be able to describe the variation in minutiae count by pattern.

7.3.5.5 The trainee shall be able to describe the variation in minutiae count by sex.

7.3.5.6 The trainee shall be able to describe the diversity of minutiae type by finger.

7.3.5.7 The trainee shall be able to describe the regional density of minutiae in fingerprints.

7.3.5.8 The trainee shall be able to describe how pattern influences minutiae direction.

7.3.5.9 The trainee shall be able to support the ~~International Association for Identification's stance~~generally accepted principle that there is no scientifically valid minimum feature count necessary to support an identification using findings from published fingerprint pattern and minutiae studies.

7.3.6 Statistics and Fingerprint Probability Models

The training program shall include sufficient information about probability and statistics theory necessary to support the learning outcomes for this topic. The training program should introduce published fingerprint statistical models.

7.3.6.1 The trainee shall be able to define the following descriptive statistics terms:

— variable,

— data,

— mean,

— median,

— mode,

— range,

— standard deviation,

— probability (subjective and objective or empirical and classical),

— propositions and competing propositions,

— frequency distributions,

— statistics.

7.3.6.2 The trainee should be able to recognize displays that illustrate the central tendency (e.g., mean, median, mode, etc~~).~~.) and variability of descriptive data (e.g., standard deviation, range etc).

7.3.6.3 The trainee should be able to explain the following concepts from probability theory:

— axioms of mathematical probability;

— definition of probability function;

— definition of conditional probability;

— transposition of a conditional probability;

— differences between a likelihood and a probability;

— relationship between probabilities and odds;

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

7.3.6.4 The trainee should be able to discuss the differences and relationship between descriptive and inferential statistics.

7.3.6.5 The trainee should be able to recognize the following concepts from inferential statistics:

— probability distribution and its parameters;

— difference between population parameters and sample statistics;

— methods to estimate a population proportion from a sample statistic;

— measurement error (including bias and random error), sampling error, and modeling error.

7.3.6.6 The trainee shall be able to distinguish between probability estimates calculated using an appropriate model and subjective estimates based upon observations interpreted using the examiner's experience.

7.3.6.7 The trainee shall be able to recognize examples of descriptive statistics and inferential statistics in fingerprint models.

7.3.6.8 The trainee should be able to recall the basic premise of fingerprint models that calculate a probability of random correspondence.

7.3.6.9 The trainee should be able to recall the basic premise of fingerprint models that calculate a likelihood ratio.

7.3.6.10 The trainee should be able to recognize the probability of random correspondence approach and the likelihood ratio approach in fingerprint models.

7.3.6.11 The trainee should be able to recognize the following conditional probabilities with respect to the results of fingerprint statistical modeling:

— sensitivity,

— specificity,

— false positive rate,

— false negative rate,

— positive predictive value,

— negative predictive value,

— false positive discovery rate,

— false negative discovery rate.

7.3.6.12 The trainee shall be able to evaluate the general strengths and limitations of fingerprint statistical models.

7.3.6.13 The trainee should be able to recall the ~~International Association for Identification's stance~~generally accepted principle that there is no scientifically valid minimum feature count necessary to support an identification using findings from published articles describing fingerprint statistical models.

7.3.6.14 The trainee shall be able to support the use of friction ridge impressions as a means of personal identification in civil and criminal applications using findings from published articles describing fingerprint statistical models.

7.4 Introduction to Fingerprints

7.4.1 Attributes of Full Exemplar Fingerprints

The training program shall include the exploration of fully rolled exemplar fingerprints and the comparison of rolled fingerprints. The exploration of the rolled exemplar fingerprints shall include the ~~macroscopic information, microscopic information~~friction ridge features , and the significance of the ~~information~~observed data . The comparisons shall contain different rolled recordings of the fingers (not duplicates of the same rolled fingerprint).

7.4.1.1 The trainee ~~should~~shall be able to describe the size and shape (outline) of rolled fingerprints.

7.4.1.2 The trainee shall be able to identify cores, deltas, and flexion creases in rolled fingerprints.

7.4.1.3 The trainee shall be able to assign pattern type, including sub-class, to rolled fingerprints.

7.4.1.4 The trainee should be able to describe the different ridge counts present in rolled fingerprints (e.g., core to delta, core to flexion crease, and delta to flexion crease).

7.4.1.5 The trainee should be able to assign inner, outer, and meet tracings in whorls.

7.4.1.6 The trainee shall be able to predict left/right handedness of rolled fingerprints based on pattern, ridge flows, and tracings and appropriately assign uncertainty to the prediction.

7.4.1.7 The trainee ~~should~~shall be able to describe the purpose, content, and organization of a typical tenprint record.

7.4.1.8 The trainee shall be able to recognize the distal orientation of rolled fingerprints using shape, ridge flows, cores, deltas, and creases.

7.4.1.9 The trainee shall be able to compare rolled impressions of the fingers, declare a match or non-match, and articulate the basis the match or non-match (e.g., similarities or ~~differences~~dissimilarities in patterns, ridge counts, crease shape, scars, and ridge arrangements).

7.4.1.10 The trainee shall be able to discuss variations in appearance (~~differences~~dissimilarities) between rolled fingerprints from the same source.

7.4.1.11 The trainee shall be able to discuss coincidental similarities in appearance between rolled fingerprints from different sources.

7.4.2 Attributes of Partial Exemplar Fingerprints

The training program shall include the exploration of clear, partial exemplar fingerprints and the comparison of partial exemplar fingerprints to rolled exemplar fingerprints. The partial fingerprints shall bear limited focal points (e.g., core is visible, but not the delta), reflect natural touches of a surface, and meet the FSP's suitability criteria.

7.4.2.1 The trainee ~~should~~shall be able to describe the size and shape (outline) of partial fingerprints.

7.4.2.2 The trainee shall be able to predict the distal orientation of partial fingerprints, consider the uncertainty of the prediction, and support the decision.

7.4.2.3 The trainee shall be able to predict left/right handedness of partial fingerprints, consider the uncertainty of the prediction, and support the decision.

7.4.2.4 The trainee shall be able to select effective target data in partial fingerprints.

7.4.2.5 The trainee shall be able to compare partial fingerprints to rolled fingerprints and ~~exploit the diagnostic macroscopic and microscopic information~~interpret the observed data to include or exclude possible candidates.

7.4.2.6 The trainee shall be able to evaluate the similarities and ~~differences~~dissimilarities (variations in appearance) between fingerprints from the same source.

7.4.2.7 The trainee shall be able to evaluate ~~differences~~dissimilarities and coincidental similarities between fingerprints from different sources.

7.4.2.8 The trainee shall be able to support conclusions with the appropriate weighting of ~~macroscopic information and microscopic information.~~observed data

7.4.3 Attributes of Tip and Edge Exemplar Fingerprints

The training program shall include the exploration of clear, fragmentary exemplar fingerprints from the tips and edges of the fingers and the comparison of fragmentary fingerprints to rolled exemplar fingerprints. The fragmentary fingerprints shall bear limited or no focal points, reflect natural touches of a surface, and meet the FSP's suitability criteria.

7.4.3.1 The trainee ~~should~~shall be able to describe the size and shape (outline) of fragmentary fingerprints.

7.4.3.2 The trainee shall be able to predict the distal orientation of fragmentary fingerprints, consider the uncertainty of the prediction, and support the decision.

7.4.3.3 The trainee shall be able to predict left/right handedness of fragmentary fingerprints, consider the uncertainty of the prediction, and support the decision.

7.4.3.4 The trainee shall be able to select effective target data in fragmentary fingerprints.

7.4.3.5 The trainee shall be able to compare fragmentary fingerprints to rolled fingerprints and ~~exploit the diagnostic macroscopic and microscopic information~~interpret the observed data to include or exclude possible candidates.

7.4.3.6 The trainee shall be able to determine when additional exemplars are required to complete a comparison.

7.4.3.7 The trainee shall be able to evaluate the similarities and ~~differences~~dissimilarities (variations in appearance) between fingerprints from the same source.

7.4.3.8 The trainee shall be able to evaluate ~~differences~~dissimilarities and coincidental similarities between fingerprints from different sources.

7.4.3.9 The trainee shall be able to support the conclusion with the appropriate weighting of ~~macroscopic information and microscopic information~~observed data.

7.5 Introduction to Proximal and Medial Phalange Prints

7.5.1 Attributes of Full Exemplar Proximal and Medial Phalange Prints

The training program shall include the exploration of full exemplar impressions of the proximal and medial portions of the fingers and the comparison of full exemplar impressions of the proximal and medial portions of the fingers. The exploration of the full exemplar proximal and medial phalange prints shall include the ~~macroscopic information, microscopic information,~~friction ridge features and the significance of ~~this information~~observed data . The comparisons shall contain different full exemplar recordings of the proximal and medial portions of the fingers (not duplicates of the same rolled impression).

7.5.1.1 The trainee ~~should~~shall be able to describe the size and shape (outline) of rolled impressions of the proximal and medial phalanges.

7.5.1.2 The trainee shall be able to identify major ridge flows in rolled impressions of the proximal and medial phalanges.

7.5.1.3 The trainee shall be able to identify the flexion creases and secondary creases in rolled impressions of the proximal and medial phalanges.

7.5.1.4 The trainee shall be able to recognize the distal orientation of rolled impressions of the proximal and medial phalanges.

7.5.1.5 The trainee shall be able to ~~differentiate~~distinguish between impressions of the proximal phalange and the medial phalange.

7.5.1.6 The trainee shall be able to describe the challenges associated with assigning distal orientation and distinguishing proximal phalange from medial phalange.

7.5.1.7 The trainee shall be able to compare rolled impressions of the proximal and medial phalanges, declare a match or non-match, and articulate the basis for the match or non-match (e.g., similarities or ~~differences~~dissimilarities in ridge flows, crease shape, scars, and ridge arrangements)

7.5.1.8 The trainee shall be able to discuss the variation in appearance (~~differences~~dissimilarities) between rolled proximal and medial phalange impressions from the same source.

7.5.1.9 The trainee shall be able to discuss coincidental similarities in appearance between rolled proximal and medial phalange impressions from different sources.

7.5.2 Attributes of Partial Exemplar Proximal and Medial Phalange Prints

The training program shall include the exploration of clear, partial exemplar impressions of the proximal and medial portions of the fingers and the comparison of partial exemplar impressions to full exemplar (rolled) impressions of the proximal and medial portions of the fingers. The partial impressions shall reflect natural touches of a surface and meet the FSP's suitability criteria.

7.5.2.1 The trainee ~~should~~shall be able to describe the size and shape (outline) of partial impressions of the proximal and medial phalanges.

7.5.2.2 The trainee shall be able to predict the distal orientation of partial impressions of the proximal and medial phalanges, consider the uncertainty of the prediction, and support the decision.

7.5.2.3 The trainee shall be able to predict left/right handedness of partial impressions of the proximal and medial phalanges, consider the uncertainty of the prediction, and support the decision.

7.5.2.4 The trainee shall be able to select effective target data in partial impressions of the proximal and medial phalanges.

7.5.2.5 The trainee shall be able to compare partial impressions of the proximal and medial phalanges to rolled impressions of the proximal and medial phalanges and ~~exploit the diagnostic macroscopic and microscopic information~~interpret the observed data to include or exclude possible candidates.

7.5.2.6 The trainee shall be able to determine when additional exemplars are required to complete a comparison.

7.5.2.7 The trainee shall be able to evaluate the similarities and ~~differences~~dissimilarities (variations in appearance) between proximal and medial phalange prints from the same source.

7.5.2.8 The trainee shall be able to evaluate the ~~differences~~dissimilarities and coincidental similarities between proximal and medial phalange prints from different sources.

7.5.2.9 The trainee shall be able to support the conclusion with the appropriate weighting of ~~macroscopic information and microscopic information~~observed data .

7.6 Introduction to Palm Prints

7.6.1 Attributes of Full Exemplar Palm Prints

The training program shall include the exploration of full exemplar recordings of the palms. The exploration of full exemplar palm prints shall include the ~~macroscopic information, microscopic information~~friction ridge features, and the significance of ~~this information~~observed data.

7.6.1.1 The trainee ~~should~~shall be able to identify the interdigital, thenar and hypothenar regions of left and right palms.

7.6.1.2 The trainee ~~should~~shall be able to describe size and shape (outline) of full palm prints.

7.6.1.3 The trainee shall be able to distinguish left palms from right palms.

7.6.1.4 The trainee should be able to recall the frequency of arch, loop, whorl, column, and vestige patterns in each region of the palm.

7.6.1.5 The trainee should be able to describe the common positions and shapes of the deltas in each region of the palm.

7.6.1.6 The trainee should be able to describe the range of variation in the number and positions of deltas in each region of the palm.

7.6.1.7 The trainee should be able to describe the relationship of deltas and patterns in each region of the palm.

7.6.1.8 The trainee shall be able to describe the major ridge flows commonly associated with each region of the palm.

7.6.1.9 The trainee shall be able to describe the location, orientation, and densities of the flexion creases and secondary creases typically associated with each region of the palm.

7.6.2 Attributes of Partial Exemplar Palm Prints

The training program shall include the exploration of clear, partial exemplar palm prints and the comparison of partial exemplar palm prints to full recordings of the palms. The partial palm prints shall reflect natural touches of a surface and meet the FSP's suitability criteria.

7.6.2.1 The trainee ~~should~~shall be able to describe the typical size and shape of impressions from each region of the palm.

7.6.2.2 The trainee shall be able to predict the palm sub-region(s) of partial palm prints, consider the uncertainty of the prediction, and support the decision.

7.6.2.3 The trainee shall be able to predict left/right handedness of partial palm prints, consider the uncertainty of the prediction, and support the decision.

7.6.2.4 The trainee shall be able to predict the distal orientation of partial palm prints, consider the uncertainty of the prediction, and support the decision.

7.6.2.5 The trainee shall be able to select effective target data in partial palm prints.

7.6.2.6 The trainee shall be able to compare partial palm prints to full palm prints and ~~exploit the diagnostic macroscopic and microscopic information~~interpret the observed data to include or exclude possible candidates.

7.6.2.7 The trainee shall be able to determine when additional exemplars are required to complete a comparison.

7.6.2.8 The trainee shall be able to evaluate the similarities and ~~differences~~dissimilarities (variations in appearance) between palm prints from the same source.

7.6.2.9 The trainee shall be able to evaluate the ~~differences~~dissimilarities and coincidental similarities between palm prints from different sources.

7.6.2.10 The trainee shall be able to support the conclusion with the appropriate weighting of ~~macroscopic information and microscopic information~~observed data .

7.7 Introduction to Foot Prints

7.7.1 Attributes of Full Exemplar Foot Prints

The training program shall include the exploration of full exemplar recordings of the feet. The exploration of full exemplar foot prints shall include the ~~macroscopic information, microscopic information~~friction ridge features , and the significance of ~~this information~~observed data .

7.7.1.1 The trainee shall be able to identify the toes, hallucal, interdigital, thenar (proximal and distal) and hypothenar (proximal and distal) and calcar regions of left and right feet.

7.7.1.2 The trainee ~~should~~shall be able to describe size and shape (outline) of full foot prints.

7.7.1.3 The trainee shall be able to distinguish left feet from right feet.

7.7.1.4 The trainee should be able to recall the frequency of arch, loop, whorl, column, and vestige patterns in each region of the foot.

7.7.1.5 The trainee should be able to describe the common positions of the deltas in each region of the foot.

7.7.1.6 The trainee should be able to describe the range of variation in the number and positions of deltas in each region of the foot.

7.7.1.7 The trainee should be able to describe the relationship of deltas and patterns in each region of the foot.

7.7.1.8 The trainee shall be able to describe the major ridge flows commonly associated with each region of the foot.

7.7.1.9 The trainee shall be able to describe the location, orientation, and densities of the flexion creases and secondary creases typically associated with each region of the foot.

7.7.2 Attributes of Partial Exemplar Foot Prints

The training program shall include the exploration of clear, partial exemplar foot prints and the comparison of partial exemplar foot prints to full recordings of the feet. The partial foot prints shall reflect natural touches of a surface and meet the FSP's suitability criteria.

7.7.2.1 The trainee ~~should~~shall be able to describe the typical size and shape of impressions from each region of the foot.

7.7.2.2 The trainee shall be able to predict the foot sub-region(s) of partial foot prints, consider the uncertainty of the prediction, and support the decision.

7.7.2.3 The trainee shall be able to predict left/right determinations of partial foot prints, consider uncertainty of the prediction, and support the decision.

7.7.2.4 The trainee shall be able to predict the distal orientation of partial foot prints, consider the uncertainty of the prediction, and support the decision.

7.7.2.5 The trainee shall be able to distinguish partial palm prints from partial foot prints and appropriately assign uncertainty to the determination of palm or foot.

7.7.2.6 The trainee shall be able to select effective target data in partial foot prints.

7.7.2.7 The trainee shall be able to compare partial foot prints to full foot prints and ~~exploit the diagnostic macroscopic and microscopic information~~interpret the observed data to include or exclude possible candidates.

7.7.2.8 The trainee shall be able to determine when additional exemplars are required to complete a comparison.

7.7.2.9 The trainee shall be able to evaluate the similarities and ~~differences~~dissimilarities (variations in appearance) between foot prints from the same source.

7.7.2.10 The trainee shall be able to evaluate the ~~differences~~dissimilarities and coincidental similarities between foot prints from different sources.

7.7.2.11 The trainee shall be able to support the conclusion with the appropriate weighting of ~~macroscopic information and microscopic information~~observed data .

7.8 Collecting Exemplar Prints

7.8.1 Introduction to Collecting Exemplar Prints

The training program shall include the reasons for collecting exemplar prints and the importance of collecting legible and complete exemplars of the friction ridge skin.

7.8.1.1 The trainee shall be able to explain why friction ridge exemplars are obtained.

7.8.1.2 The trainee shall be able to explain the importance of taking clear and complete recordings of the friction ridge skin.

7.8.1.3 The trainee shall be able to explain the ~~differences~~dissimilarities between standard recordings of the fingers and palms and complete friction ridge exemplars (major case prints).

7.8.1.4 The trainee shall be able to evaluate exemplar prints for completeness and clarity.

7.8.2 Methods of Collecting Exemplar Prints

The training program shall include the methods used by the FSP or submitting agencies for the collection of exemplar prints from intact friction ridge skin and the challenges and limitations associated with each method. The level of instruction and level of comprehension of the trainee is dependent on the job requirements.

7.8.2.1 The trainee shall be able to recognize the different methods of collecting exemplar prints (e.g., ink, lifters, and digital capture).

7.8.2.2 The trainee shall be able to describe the basic process for each method of collecting exemplar prints for fingers, palms, and feet.

7.8.2.3 The trainee shall be able to describe the typical sources of distortion for each method (e.g., over-inking, under-inking, too much pressure, too little pressure, overlays/double touches, slippage, smearing, and stitching errors, digital artifacts).

7.8.2.4 The trainee shall be able to determine when exemplar prints should not be used for comparison (e.g., poor resolution).

7.8.2.5 If a required job function the trainee shall be able to list the necessary documentation when obtaining exemplar prints.

7.8.2.6 If a required job function, the trainee shall be able to collect standard exemplar prints of the fingers, palms, and feet using each method approved by the FSP.

7.8.2.7 If a required job function, the trainee shall be able to collect complete friction ridge exemplars (major case prints) of the fingers, palms, and feet using each method approved by the FSP.

7.8.3 Collecting Exemplar Prints under Special Circumstances

The training program shall include the methods used by the FSP or submitting agencies to collect exemplar prints from deceased and degraded friction ridge skin and the challenges and limitations associated with each method. The level of instruction and level of comprehension of the trainee is dependent on the job requirements.

7.8.3.1 The trainee shall be able to describe the basic process for each method of collecting exemplar prints from deceased subjects with intact friction ridge skin.

7.8.3.2 The trainee shall be able to describe the types of distortion expected in exemplar prints from deceased subjects with intact friction ridge skin.

7.8.3.3 If a required job function, the trainee shall be able to collect exemplar prints from deceased subjects with intact friction ridge skin.

7.8.3.4 The trainee shall be able to describe the basic process for collecting exemplar prints from friction ridge skin in the following conditions: decomposed, macerated, desiccated and charred.

7.8.3.5 The trainee shall be able to describe the types of distortion expected in exemplar prints from friction ridge skin in the following conditions: decomposed, macerated, desiccated and charred.

7.8.3.6 If a required job function, the trainee shall be able to collect exemplar prints from friction ridge skin in the following conditions: decomposed, macerated, desiccated and charred.

7.9 Examination Method

7.9.1 Introduction to Logic and Reasoning

The training program shall include an introduction to logic ~~and~~, reasoning, and human factors (see 7.11) as it pertains to the examination of friction ridge impressions.

7.9.1.1 The trainee shall be able to explain how inferences are formed using deductive, inductive, and abductive logic.

7.9.1.2 The trainee shall be able to describe circumstances in which deductive, inductive, and abductive logic are utilized to make inferences.

7.9.1.3 The trainee should be able to evaluate the strengths and limitations of the different forms of logic used to make inferences.

7.9.1.4 The trainee should be able to debate the benefits and limitations of reporting discrete examination conclusions.

7.9.1.5 The trainee should be able to debate the benefits and limitations of reporting continuous statistical conclusions (posterior probabilities, likelihood ratio, Bayes factor, and conditional match probability).

7.9.1.6 The trainee should be able to recognize fallacies of logic, faulty reasoning, circular reasoning, transposing the conditional, prosecutor's fallacy, and appeal to authority.

7.9.2 Visual Interpretation of Ridge Detail in Latent Prints: Residue

The training program shall include the visual effects of the following on the appearance of ~~macroscopic and microscopic information~~friction ridge features in friction ridge impressions: the types of residue, sebaceous secretions, eccrine sweat, combined sebaceous and eccrine sweat, and blood, commonly found on the friction ridge skin; variations in the distribution of residue on the skin; and the deposition of the residue onto surfaces.

7.9.2.1 The trainee should be able to recognize the effects various residues can have on the appearance of latent prints.

7.9.2.2 The trainee should be able to describe potential variations in the distribution of residue on the surface of the skin.

7.9.2.3 The trainee should be able to explain how the residue is deposited to a surface and how the distribution of the residue impacts the manner in which the residue is deposited.

7.9.2.4 The trainee should be able to predict the appearance of the contact regions (e.g. tops of the ridges) and non-contact regions (e.g., furrows, creases, and wrinkles) of the skin given the different ways the residue can be distributed on the surface of the skin.

7.9.3 Visual Interpretation of Ridge Detail in Latent Prints: Contact

The training program shall include the visual effects of the following on the appearance of ~~macroscopic and microscopic information~~friction ridge features in friction ridge impressions: variations in deposition pressure when the skin contacts surface; movement of the skin on the surface and the redistribution of residue onto a surface; changes in deposition pressure as the skin moves on the surface; and combined residue and touch factors.

7.9.3.1 The trainee should be able to recognize global deposition pressure based on the size and shape of impressions and the nature of the surface touched.

7.9.3.2 The trainee should be able to recognize local variations in deposition pressure within one contact with the surface (i.e., within one impression) based on the ridge and furrow dimensions.

7.9.3.3 The trainee should be able to explain localized deposition pressures within one contact of the surface due to the anatomy of the hand or foot and the nature of the surface touched.

7.9.3.4 The trainee should be able to predict the variation in appearance of the ridges and furrows throughout an impression due to localized deposition pressures and variations in residue distribution on the skin.

7.9.3.5 The trainee should be able to define the following terms related to skin contact with a surface: stick region, incipient slip, and gross slip.

7.9.3.6 The trainee shall be able to describe the visual cues that indicate the skin moved laterally (sheering stress) or twisted (torque) on porous and non-porous surfaces.

7.9.3.7 The trainee should be able to describe how the residue is redistributed on the surface when the skin experiences incipient slip or gross slip.

7.9.3.8 The trainee should be able to predict the variation in the appearance of the ridges and furrows throughout an impression due to the redistribution of the residue on the surface during incipient slip or gross slip.

7.9.3.9 The trainee shall be able to describe the visual cues (e.g. misaligned ridges and furrows) that indicate the skin changed pressure during an incipient slip or gross slip.

7.9.3.10 The trainee shall be able to describe the visual cues that skin made multiple contacts with a surface (e.g. interference patterns).

7.9.4 Visual Interpretation of Ridge Detail in Latent Prints: Surfaces

The training program shall include the visual effects of the following on the appearance of ~~macroscopic and microscopic information~~friction ridge features in friction ridge impressions: deformation of the friction ridge skin with commonly touched surfaces (e.g. flat versus curved surfaces); the interaction of friction ridge skin residue with commonly touched surfaces; the introduction of background noise by textured surfaces; the introduction of background noise by surface contaminants; the interaction of latent print residue with surface contaminants; and combined residue, touch and surface factors.

7.9.4.1 The trainee shall be able to explain how the shape of surfaces touched can affect the appearance of friction ridge impressions (e.g., flat and contoured surfaces).

7.9.4.2 The trainee shall be able to explain how the firmness of surfaces touched can affect the appearance of friction ridge impressions.

7.9.4.3 The trainee shall be able to explain how the texture of surfaces touched can affect the appearance of friction ridge impressions.

7.9.4.4 The trainee shall be able to explain how interactions of latent print residues with typical surfaces can affect the appearance of friction ridge impressions.

7.9.4.5 The trainee shall be able to explain how interactions of latent print residues with surface contaminants can affect the appearance of friction ridge impression.

7.9.4.6 The trainee shall be able to explain how the displacement or removal of surface contaminants by the skin can affect the appearance of friction ridge impressions.

7.9.5 Visual Interpretation of Ridge Detail in Latent Prints: Processing Technique

For each processing technique used by the FSP or submitting agencies, the training program shall include the visual effects of the following on the appearance of ~~macroscopic and microscopic information~~friction ridge features in friction ridge impressions: the reaction of the processing technique to the latent print residue; the reaction of the processing technique to surface contaminants; the recovery method (e.g., type of photography or lifting); sequential processing; and combined residue, touch, surface, and processing factors.

7.9.5.1 The trainee shall be able to describe the general use of each processing technique used by the FSP or submitting agencies.

7.9.5.2 The trainee shall be able to recognize friction ridge impressions developed with different processing techniques.

7.9.5.3 The trainee shall be able to explain how interactions of the processing technique with surface contaminants can affect the appearance of friction ridge impressions.

7.9.5.4 The trainee shall be able to explain how time and environmental conditions (from the time the impression was deposited to when it was recovered) can affect the appearance of friction ridge impressions.

7.9.5.5 The trainee shall be able to explain how the methods used to preserve impressions can affect the appearance of friction ridge impressions.

7.9.6 Introduction to Digital Imaging

If the FSP uses digital imaging software to document or enhance friction ridge impressions, the training program shall include instruction on the use of the software, basic digital imaging concepts, and FSP approved digital processing techniques and tools.

7.9.6.1 The trainee shall be able to explain the following concepts and the relationships between the concepts: image resolution, file compression, image size, and file types.

7.9.6.2 The trainee shall be able to select the appropriate methods to digitally enhance friction ridge impressions.

7.9.6.3 The trainee shall be able to select the appropriate tools for documenting friction ridge impressions.

7.9.6.4 The trainee shall be able to follow FSP procedures for saving images of friction ridge impressions.

7.9.7 Analysis

The training program shall include the process for detecting ~~macroscopic and microscopic information~~friction ridge features , thresholds for suitability decisions, documentation of suitable friction ridge impressions, establishment of search parameters (anatomical region, distal orientation and associated uncertainties), documentation of search parameters, and detection of forged or fabricated prints.

7.9.7.1 The trainee shall be able to detect the ~~macroscopic and microscopic information~~friction ridge features in friction ridge impressions under various combinations of: residue, contact, surface, and processing technique.

7.9.7.2 The trainee shall be able to predict the range of variation in appearance of ~~macroscopic and microscopic information~~friction ridge features (also known as "tolerance") among friction ridge impressions from the same source under various combinations of: residue, contact, surface, processing technique, and exemplar recording technique.

7.9.7.3 The trainee shall be able to ~~evaluate~~describe how false minutiae could be created by factors associated with residue, contact, surface, and processing technique.

7.9.7.4 The trainee shall be able to indicate debatable minutiae.

7.9.7.5 The trainee shall be able to categorize friction ridge impressions as "suitable" or "not suitable" for comparison based on the significance of the ~~information in the impression (macroscopic and microscopic)~~observed data and FSP requirements.

7.9.7.6 The trainee shall be able to support "suitable" and "not suitable" decisions per their FSP requirements.

7.9.7.7 The trainee shall be able to explain the reasons friction ridge impressions may display debatable suitability.

7.9.7.8 The trainee shall be able to document suitability decisions and consultations per FSP requirements.

7.9.7.9 The trainee shall be able to predict the anatomical region(s) represented in friction ridge impressions, consider the uncertainty of the prediction, and support the decision.

7.9.7.10 The trainee shall be able to predict the distal orientation of friction ridge impressions, consider the uncertainty of the prediction, and support the decision.

7.9.7.11 The trainee shall be able to document anatomical region, distal orientation, and associated uncertainties per FSP requirements.

7.9.7.12 If a required job function, the trainee shall be able to categorize friction ridge impressions as "suitable" or "not suitable" for ABIS (Automated Biometric Identification System) search based on the ~~information in the impression (macroscopic and microscopic)~~observed data and FSP requirements.

7.9.7.13 If a required job function, the trainee shall be able to support ~~AFIS~~ABIS "suitable" and "not suitable" decisions.

7.9.7.14 If a required job function, the trainee shall be able to document ~~AFIS~~ABIS suitability decisions per FSP requirements.

7.9.7.15 The trainee shall be able to recognize common methods of forged or fabricated friction ridge impressions.

7.9.8 Comparison

The training program shall include the selection of target data in the questioned friction ridge impression, the process for searching target data through exemplar prints, and the side by side comparison of a questioned and exemplar print.

7.9.8.1 The trainee shall be able to select effective target data in the questioned friction ridge impression.

7.9.8.2 The trainee shall be able to search target data in questioned friction ridge impressions through exemplar friction ridge impressions and ~~exploit the diagnostic macroscopic and microscopic information~~interpret the observed data to include or exclude possible candidates.

7.9.8.3 The trainee shall be able to determine when additional exemplars are required to complete a comparison.

7.9.8.4 The trainee shall be able to compare (side-by-side) questioned and exemplar friction ridge impressions and detect similarities and ~~differences in the diagnostic macroscopic and microscopic information~~dissimilarities in the observed data.

7.9.8.5 The trainee shall be able to weigh the similarities and ~~differences~~dissimilarities between impressions from the same source.

7.9.8.6 The trainee shall be able to weigh the similarities and ~~differences~~dissimilarities between impressions from different sources.

7.9.8.7 The trainee shall be able to document comparisons per FSP requirements.

7.9.9 Evaluation

The training program shall include the inferential process and thresholds for rendering source conclusions as required by the FSP.

7.9.9.1 The trainee shall ~~to~~ be able to formulate appropriate source conclusions.

7.9.9.2 The trainee shall be able to support source conclusions with the appropriate weighing of ~~macroscopic information and microscopic information~~observed data per their FSP requirements.

7.9.9.3 The trainee shall be able to predict which comparisons may result in debatable conclusions and require consultation with colleagues.

7.9.9.4 The trainee shall be able to describe a close non-match comparison and list published examples.

~~**7.9.9.4**~~**7.9.9.5** The trainee shall be able to explain the reasons comparisons may result in debatable conclusions.

~~**7.9.9.5**~~**7.9.9.6** The trainee shall be able to document source conclusions and consultations per FSP requirements.

7.9.9.7 The trainee shall be able to articulate the differences between absolute conclusions compared to a range of conclusions.

7.9.10 Statistical Software

If the FSP uses statistical software to support or refute examiner decisions or provide a numerical value of weight of evidence for reporting, the training program shall include the theoretical basis for the software and the use of the software.

7.9.10.1 The trainee shall be able to describe the validation of the software.

7.9.10.2 The trainee shall be able to explain how the software generates results.

7.9.10.3 The trainee shall be able to assess the significance of the results generated by the software.

7.9.10.4 The trainee shall be able to explain factors that impact the performance of the software.

7.9.10.5 The trainee shall be able to explain the limitations of the software.

7.9.10.6 The trainee shall be able to operate the software per FSP requirements.

7.9.10.7 The trainee shall be able to document software results per FSP requirements.

7.10 Performance Studies

7.10.1 Introduction to Error Rate Calculations and Confidence Intervals

The training program shall include an overview of error rate testing, methods and limitations of calculating error rates, the application of confidence intervals to error rates. Additionally, the training program shall include the concepts of foundational validity and validity as applied with respect to pattern evidence.

7.10.1.1 The trainee shall be able to explain the purpose of error rate testing of friction ridge examiners.

7.10.1.2 The trainee shall be able to define the following concepts related to error rate testing:

— accuracy,

— reproducibility,

— repeatability,

— reliability.

7.10.1.3 The trainee should be able to recognize the following conditional probabilities with respect to the results of error rate testing:

— sensitivity,

— specificity,

— false positive rate,

— false negative rate,

— positive predictive value,

— negative predictive value,

— false positive discovery rate,

— false negative discovery rate.

7.10.1.4 The trainee shall be able to recite the application of confidence intervals to the results of error rate testing.

7.10.1.5 The trainee shall be able to recite the significance of confidence intervals as they pertain to error rate testing.

7.10.1.6 The trainee shall be able to recite "foundational validity" and "validity as applied" as discussed in the 2016 President's Council of Advisor's on Science and Technology (PCAST) report, *Forensic Science in Criminal Courts: Ensuring Scientific Validity of Feature Comparison Methods*.

7.10.2 Expert Versus Novice Studies

The training program shall include the results, significance and limitations of published research evaluating the differences between the performance of novices and trained friction ridge examiners (experts).

7.10.2.1 The trainee should be able to explain the differences novices and experts display during the analysis of friction ridge impressions.

7.10.2.2 The trainee should be able to explain the differences novices and experts display during the comparison of friction ridge impressions.

7.10.2.3 The trainee shall be able to explain the differences novices and experts display during the evaluation of friction ridge impressions.

7.10.2.4 The trainee shall be able to evaluate the strengths and limitations of the studies comparing novices to experts.

7.10.2.5 The trainee shall be able to assess the value of training for the examination of friction ridge impressions.

7.10.2.6 The trainee shall be able to support the use of trained examiners for rendering of source conclusions for friction ridge impressions with findings from the novice versus expert studies.

7.10.3 Expert Studies

The training program shall include the results, significance, and limitations of published studies evaluating the performance of trained friction ridge examiners.

7.10.3.1 The trainee should be able to describe the general design of published performance studies.

7.10.3.2 The trainee should be able to evaluate the strengths and limitations of the performance studies.

7.10.3.3 The trainee should be able to explain the error rate findings from the performance studies.

7.10.3.4 The trainee should be able to consider reasons for variation in examiner suitability decisions in the performance studies.

7.10.3.5 The trainee should be able to consider reasons for variation in examiner conclusions in the performance studies.

7.10.3.6 The trainee should be able to consider reasons for variation in examiner mark-up of images in the performance studies.

7.10.3.7 The trainee should be able to assess the ability to infer casework error rates from error rate studies.

7.10.3.8 The trainee should be able to consider the challenges of calculating error rates from casework.

7.10.3.9 The trainee should be able to support the use of trained examiners in the rendering of source conclusions for friction ridge impressions with findings from the examiner performance studies.

7.11 Human Factors and Quality Assurance

7.11.1 Human Factors

The training program shall include significant human factors that may impact the performance of the examiners. The training program shall include factors from the following four realms listed in the 2012 Expert Working Group on Human Factors in the Analysis of Latent Prints report, *Latent Print Examination and Human Factors: Improving Practice through a Systems Approach*: analyst actions, analyst conditions, supervisory issues, and organizational issues.

7.11.1.1 The trainee should be able to describe decision-based mistakes that could be made by an examiner.

7.11.1.2 The trainee should be able to describe skill-based mistakes that could be made by an examiner.

7.11.1.3 The trainee should be able to describe perception-based mistakes that could be made by an examiner.

7.11.1.4 The trainee should be able to describe violations that could be committed by an examiner.

7.11.1.5 The trainee should be able to discuss the adverse mental states that could affect examiner performance.

7.11.1.6 The trainee should be able to discuss the adverse physiological states that could affect examiner performance.

7.11.1.7 The trainee should be able to explain how communication could affect examiner performance.

7.11.1.8 The trainee should be able to discuss the physical or mental limitations that could affect examiner performance.

7.11.1.9 The trainee should be able to explain how the technical environment could affect examiner performance.

7.11.1.10 The trainee should be able to explain how the physical environment could affect examiner performance.

7.11.1.11 The trainee should be able to discuss the supervisory leadership failures that could affect examiner performance.

7.11.1.12 The trainee should be able to explain how a supervisor's failure to correct known problems could affect examiner performance.

7.11.1.13 The trainee should be able to discuss the supervisory operational planning failures that could affect examiner performance.

7.11.1.14 The trainee should be able to discuss the supervisory violations that could affect examiner performance.

7.11.1.15 The trainee should be able to discuss organizational resource management failures that could affect examiner performance.

7.11.1.16 The trainee should be able to explain how an FSP's operational processes could affect examiner performance.

7.11.1.17 The trainee should be able to explain how the organization's climate could affect examiner performance.

7.11.1.18 The trainee should be able to ~~evaluate the~~discuss potential human factors associated with ~~the~~errors in cases ~~concerning the erroneous identification of the following individuals~~such as: John Orr (1991), Shirley McKie (1999), Mark Miller (2001), Brandon Mayfield (2004), Dexter Presnell (2005), Lana Canen (2012) and Alton Dandridge (2015~~).~~).

7.11.1.19 The trainee should be able to ~~evaluate~~discuss the potential human factors associated with ~~the following~~ forgery and fabrication cases such as: William DePalma (fabrication 1967), Herman Wiggins (fabrication 1970's), NY State Troop "C" (fabrication 1989), Frederik van der Vyver (fabrication 2005), and Peter Paul Biro (Jackson Pollack forgery 2008).

7.11.1.20 The trainee should be able to describe cognitive bias and list the major studies and their applicability to friction ridge examinations.

7.11.2 Quality Assurance

The training program shall include the quality assurance processes adopted by the FSP to improve the performance of the examiners. The training program shall include those learning objectives that are relative to the FSP's quality program.

7.11.2.1 The trainee should be able discuss the importance of testing during the hiring process.

7.11.2.2 The trainee should be able discuss the importance of testing during the training program.

7.11.2.3 The trainee shall be able discuss the importance of competency testing at the completion of training.

7.11.2.4 The trainee shall be able to describe the frequency, purpose, and importance of proficiency testing.

7.11.2.5 The trainee shall be able to describe the frequency, purpose, and importance of internal audits.

7.11.2.6 The trainee shall be able to describe the frequency, purpose, and importance of external audits.

7.11.2.7 The trainee shall be able to describe method(s) of verification used by the ~~FSP~~discipline and importance and limitations of each method.

7.11.2.8 The trainee shall be able to describe method(s) of case review used by the FSP and purpose of each method.

7.11.2.9 The trainee shall be able to describe the method(s) of testimony review used by the FSP and purpose of the method.

7.11.2.10 The trainee shall be able to describe the method(s) of conflict resolution used by the FSP and purpose of each method.

7.11.2.11 The trainee shall be able to describe the methods and goals of corrective actions and preventative actions used by the FSP.

7.11.2.12 The trainee shall be able to explain the importance of case documentation to quality assurance.

7.11.2.13 The trainee shall be able to describe the methods used by the FSP to shield the examiners from undue internal and external pressure.

7.11.2.14 If an FSP is accredited, the trainee shall be able to describe the basic process for achieving and maintaining accreditation.

7.12 Testimony

7.12.1 Admissibility of Expert Testimony

The training program shall include the history of expert testimony; applicable federal, state, and local rules for expert opinion testimony; the purpose of motions *in limine* to exclude expert testimony; the process and purpose of evidentiary hearings; and common regional challenges to the admissibility of friction ridge evidence.

7.12.1.1 The trainee should be able to recite the history of expert testimony in the United States.

7.12.2 Responsibilities of the Expert Witness

The training program shall include expectations of the expert witness in responding to subpoenas, discovery and disclosure, court orders, preparation for trials or hearings, and testimony.

7.12.2.1 The trainee shall be able to recall the FSP's requirements for responding to a subpoena.

7.12.2.2 The trainee shall be able to explain the importance of discovery and disclosure and describe the FSP's requirements for responding to discovery motions and court orders~~.~~ (e.g., Brady/Giglio).

7.12.2.3 The trainee shall be able to explain the importance of a pre-trial ~~conferences~~conference with either the prosecution and/or defense, and general preparation for testimony.

7.12.2.4 The trainee shall be able to describe the appropriate ~~clothing~~professional attire to be worn for court.

7.12.2.5 The trainee shall be able to describe the layout of the courtroom and the typical location of the judge, jury, court reporter, witness, prosecution, and defendant.

7.12.2.6 The trainee shall be able to describe the roles of the judge, jury, court reporter, prosecution, and defense.

7.12.2.7 The trainee shall be able to describe the jurisdiction's rules for entering and exiting the witness stand.

7.12.2.8 The trainee shall be able to describe technology in the courtroom that may be used by witnesses.

7.12.2.9 The trainee shall be able to explain methods of effective communication with juries, judges, and attorneys.

7.12.2.10 The trainee shall be able to explain the importance of appropriate courtroom demeanor and etiquette.

7.12.2.11 The trainee shall be able to describe the appropriate response when an objection is raised.

7.12.2.12 The trainee shall be able to describe the jurisdiction's process for referring to notes, reports, or other materials.

7.12.2.13 The trainee shall be able to explain the implications of social media on the credibility of expert witnesses.

7.12.3 Qualifications

The training program shall include the presentation of education, training, and experience during testimony.

7.12.3.1 The trainee shall be able to prepare a curriculum ~~vitea~~vitae (CV).

7.12.3.2 The trainee shall be able to recite their formal education (e.g., university and degree obtained).

7.12.3.3 The trainee shall be able to describe the training program they have completed and explain the significance of the training program.

7.12.3.4 The trainee shall be able to recite the title and general description of any relevant formal training courses completed.

7.12.3.5 The trainee shall be able to describe any memberships to professional organizations and the significance of those memberships.

7.12.3.6 The trainee shall be able to describe any professional certifications ~~received~~available and the significance of those certifications.

7.12.3.7 The trainee shall be able to describe casework experience in friction ridge examinations.

7.12.3.8 The trainee shall be able to explain the importance of accurately describing qualifications and the legal implications of misrepresenting education, training, or experience.

7.12.3.9 The trainee shall be able to explain why an expert's qualifications may be challenged under cross-examination.

7.12.4 Direct Examination

The training program shall include the methods and purpose of direct examination.

7.12.4.1 The trainee shall be able to describe the types of testimony experts are allowed to provide.

7.12.4.2 The trainee shall be able to explain the difference between facts and opinions (inferences).

7.12.4.3 The trainee should be able to explain the concept of "ultimate issue" and limitations of expert testimony on ultimate issues in a case.

7.12.4.4 The trainee shall be able to explain the importance of testifying within their expertise and the possible consequences of testifying beyond their expertise.

7.12.4.5 The trainee shall be able to explain the importance of chain of custody of evidence.

7.12.4.6 The trainee shall be able to describe what a "leading question" is and how leading questions are used during direct-examination.

~~**7.12.4.6**~~**7.12.4.7** The trainee should be able to ~~describe~~recognize the general process attorneys use to develop, promote, and employ their theory of a case and the expert witness's ethical obligation to stay within the supportable bounds of their discipline during testimony.

7.12.5 Cross Examination

The training program shall include the purpose and methods of cross-examination.

7.12.5.1 The trainee shall be able to explain the importance of cross-examination as guaranteed by the Sixth Amendment of the United States Constitution.

7.12.5.2 The trainee ~~shall~~should be able to ~~predict~~anticipate which ~~learned treatises (books or written authorities)~~references in the friction ridge discipline may be used ~~to impeach expert testimony.~~during questioning .

7.12.5.3 The trainee shall be able to formulate responses to ~~learned treatises~~references in the friction ridge discipline commonly used ~~to impeach expert testimony~~during questioning.

7.12.5.4 The trainee shall be able to describe what a "leading question" is and how leading questions are used during cross-examination.

7.12.5.5 The trainee ~~shall~~should be able to ~~explain~~recognize general cross-examination methods used to control the testimony of the witness and the witness's ethical obligation to maintain accuracy and transparency during testimony.

7.12.6 Mock Trial Process

The training program shall include a mock trial process. This FSP shall determine the specific details of the mock trial process; however, it is recommended that a series of increasingly difficult mock trials are completed. For instance, the trainee may undergo a series of four mock trials in the following order:

1) qualifying questions;

2) qualifying questions and case specific direct examination;

3) qualifying questions, case specific direct examination, and case specific cross-examination;

4) qualifying questions, evidentiary hearing direct examination, evidentiary hearing cross-examination, case specific direct examination, and case specific cross-examination.

The mock trial process shall include formal and specific feedback for the trainee after completion of each mock trial. The mock trial process shall support all ~~of~~ the learning objectives listed below.

7.12.6.1 The trainee shall be able to follow appropriate ~~dress code~~professional attire for court.

7.12.6.2 The trainee shall be able to display appropriate demeanor and etiquette.

7.12.6.3 The trainee shall be able to communicate effectively with juries, judges, and attorneys.

7.12.6.4 The trainee shall be able to respond appropriately to objections.

7.12.6.5 The trainee shall be able to follow the appropriate process when referring to notes, reports, or other materials.

7.12.6.6 The trainee shall be able to articulate their qualifications (education, training, experience, professional organizations, and certifications as applicable)

7.12.6.7 The trainee shall be able to articulate the method for receiving evidence and requests for examinations.

7.12.6.8 The trainee shall be able to articulate FSP evidence handling (including chain of custody) and marking procedures.

7.12.6.9 The trainee shall be able to articulate the manner in which the three-dimensional features of the skin transfer information about the skin to a two-dimensional impression.

7.12.6.10 The trainee shall be able to articulate the factors that affect the quantity and clarity of friction ridge impressions.

7.12.6.11 The trainee shall be able to articulate the types and significance of the friction ridge skin features that can be transferred to a surface.

7.12.6.12 The trainee shall be able to articulate the basis for the discriminating power of the features of the friction ridge skin using concepts from the embryological development, findings of twin studies, findings of statistical models, and empirical observations.

7.12.6.13 The trainee shall be able to articulate the basis for the persistent nature of the features of the friction ridge skin using the structure and physiology of the skin and empirical observations.

7.12.6.14 The trainee shall be able to articulate the analysis process and the basis for suitability and search parameter decisions.

7.12.6.15 The trainee shall be able to articulate the selection of target data, the ~~diagnostic macroscopic and microscopic information~~observed data that guides the comparison process, and the weighting of similarities and ~~differences~~dissimilarities.

7.12.6.16 The trainee shall be able to articulate the possible source conclusions that can be rendered after comparison, the inferential process for rendering source conclusions, and thresholds for rendering source conclusions.

7.12.6.17 If applicable, the trainee shall be able to articulate the basis for categorical conclusions.

7.12.6.18 If applicable, the trainee shall be able to articulate the basis for statistical results.

7.12.6.19 As applicable, the trainee shall be able to articulate the strengths and limitations of categorical conclusions or statistical results.

7.12.6.20 The trainee shall be able to articulate the significance of the studies comparing novices to trained friction ridge examiners.

7.12.6.21 The trainee shall be able to articulate the significance of the studies evaluating error rates of trained friction ridge examiners.

7.12.6.22 The trainee shall be able to articulate the significance of human factors in examiner performance and the quality assurance processes in place to improve performance.

7.12.6.23 The trainee shall be able to articulate facts and inferences within the supportable bounds of the friction ridge examination discipline.

7.13 Automated Biometric Identification Systems (ABIS)

7.13.1 Image Acquisition

The training program shall include an introduction to the processes associated with the image capture of friction ridge impressions in ABIS if trainees will perform these job functions.

7.13.1.1 The trainee shall be able to describe the types of friction ridge recordings captured by ABIS (e.g., rolled, flat, simultaneous, palm, and supplemental impressions).

7.13.1.2 The trainee shall be able to describe the methods of friction ridge capture by ABIS (e.g., livescan or card scan).

7.13.1.3 The trainee shall be able to describe the types of capture devices used by ABIS (e.g., livescan, flatbed scanner, and camera).

7.13.1.4 The trainee shall be able to explain point of capture variables (e.g., condition of the friction ridge skin, condition of the platen, rolling speed, ink volume, and movement).

7.13.1.5 The trainee shall be able to explain control measures needed to achieve quality friction ridge images (e.g., scan resolution, compression rate, equipment maintenance, and calibration).

7.13.1.6 The trainee shall be able to describe procedures for addressing amputations, temporary injuries, skin conditions, and rescans.

7.13.1.7 The trainee shall be able to describe FSP livescan operator training policies (if applicable).

7.13.2 Function and Use of ABIS

The training program shall include an introduction to ABIS functionality, ABIS interoperability, and the general use of ABIS if trainees will perform these job functions.

7.13.2.1 The trainee should be able to explain the ABIS processes related to acquisition, classification, search, storage, retrieval, identification, and reporting.

7.13.2.2 The trainee shall be able to describe composite records and multi-incident systems.

7.13.2.3 The trainee shall be able to describe the ABIS friction ridge search criteria (e.g., designation of finger or palm search and designation of specific fingers or palm regions)

7.13.2.4 The trainee should be able to explain the system controls that ensure completeness, image quality, and data integrity.

7.13.2.5 The trainee shall be able to recall practices detailed in FSP ABIS user guides.

7.13.2.6 The trainee shall be able to describe ABIS system tolerance for image rotation.

7.13.2.7 The trainee shall be able to explain factors related searching and matching minutiae in ABIS (e.g., minutiae extraction, minutiae matching, minutiae placement, minutiae rotation, and ridge counts between minutiae).

7.13.2.8 The trainee should be able to describe the Extended Feature Set (EFS) image and feature search profiles as detailed in the National Institute of Standards and Technology Special Publication 1151, *Markup Instructions for Extended Feature Sets*.

7.13.2.9 The trainee should be able to describe ANSI NIST record types (Type-1, Type-2, Type-4, Type-9, Type-13, Type-14, Type-15) and their importance for ABIS interoperability.

7.13.2.10 The trainee shall be able to describe how friction ridge images are correlated with personal descriptors in ABIS.

7.13.2.11 The trainee should be able to explain the significance of the range of candidate scores, threshold scoring, candidate list, and candidate list scores from ABIS.

7.13.2.12 The trainee should be able to describe the search capabilities of the ABIS (e.g., latent to latent, latent to tenprint, tenprint to latent, tenprint to tenprint, latent to latent, and palm print to palm print).

7.13.2.13 The trainee should be able to explain the "lights out" process of searching in ABIS.

7.13.2.14 The trainee shall be able to list the ABIS search progression options and procedures as defined by the FSP (e.g., local, state, regional, national, and international).

7.13.2.15 The trainee shall be able to explain the benefits and risks of using ABIS search parameters to limit database penetration (e.g., finger position, sex, pattern classification and referencing race, offense, and geographical location).

7.13.2.16 The trainee shall be able to describe search result outcomes in ABIS (e.g., ranked order, unique identifier, and finger or palm position).

7.13.2.17 The trainee should be able to explain image properties and compression issues associated with ABIS (e.g., potential loss of quality due to compression of images, monitor resolution, and capture resolution).

7.13.2.18 The trainee shall be able to explain printer technology limitations and the quality degradation of printed images compared to digital images (on screen) and original lift cards.

7.13.2.19 The trainee shall be able to explain the manual encoding and automatic encoding process in ABIS.

7.13.2.20 The trainee shall be able to recite the record authentication processes used by ABIS (e.g., correct association of name, unique identifier, and friction ridge images).

7.14 Latent Print Processing

7.14.1 Reagent Preparation

If latent print reagent preparation is an expected job function of the trainee, the training program shall include the following: reagent preparation and labeling, chemical hygiene, safety equipment, and FSP documentation requirements.

7.14.1.1 The trainee shall be able to prepare latent print development reagents following FSP approved methods.

7.14.1.2 The trainee shall be able to follow proper chemical hygiene procedures and (e.g., using fume hoods and personal protective equipment).

7.14.1.3 The trainee shall be able to follow FSP requirements for documenting and labeling prepared reagents.

7.14.1.4 The trainee shall be able to assign expiration dates to prepared reagents per FSP requirements.

7.14.1.5 The trainee shall be able to follow FSP requirements for quality control checks of prepared reagents.

7.14.1.6 The trainee shall be able to interpret Safety Data Sheets (SDSs).

7.14.1.7 The trainee shall be able to follow FSP requirements for the storage of chemicals and reagents.

7.14.1.8 The trainee shall be able to follow FSP requirements for the disposal of chemicals and reagents.

7.14.1.9 The trainee shall be able to operate and maintain safety equipment provided by the FSP (e.g., eye wash stations and personal safety showers).

7.14.2 Equipment Maintenance and Performance Checks

If equipment maintenance and performance checks are an expected job function of the trainee, the training program shall include the following for each piece of equipment that must be checked or maintained: method of the equipment check, frequency of checks, method of maintenance, frequency of maintenance, and the documentation.

7.14.2.1 The trainee shall be able to check the performance of the required equipment per FSP policy.

7.14.2.2 The trainee shall be able to maintain the required equipment per FSP policy.

7.14.2.3 The trainee shall be able to document performance checks, maintenance, and service calls of the required equipment per FSP policy.

7.14.3 Latent Print Processing Methods

If latent print processing is an expected job function of the trainee, the training program shall include the following for each latent print processing method: reagent application, equipment, recovery method, quality controls, chemical hygiene, safety equipment, and FSP documentation requirements.

7.14.3.1 The trainee shall be able to apply each reagent to the appropriate type of item, type of surface, or targeted latent residue.

7.14.3.2 The trainee shall be able to follow proper chemical hygiene procedures and (e.g., using fume hoods and personal protective equipment).

7.14.3.3 The trainee shall be able to safely operate the necessary equipment associated with each development technique (e.g., fuming chamber, environmental chamber, or light source).

7.14.3.4 The trainee shall be able to select the correct sequence of reagents according to the type of item, type of surface, or expected latent residue.

7.14.3.5 The trainee shall be able to document the results of each latent print development technique per FSP requirements.

7.14.3.6 The trainee shall be able to interpret Safety Data Sheets (SDSs).

7.14.3.7 The trainee shall be able to follow FSP requirements for quality control checks of prepared reagents.

7.14.3.8 The trainee shall be able to follow FSP requirements for the storage of chemicals and reagents.

7.14.3.9 The trainee shall be able to follow FSP requirements for the disposal of chemicals and reagents.

7.14.3.10 The trainee shall be able to operate and maintain safety equipment provided by the FSP (e.g., eye wash stations and personal safety showers).

7.14.4 Forensic Photography

If latent print photography is an expected job function of the trainee, the training program shall include basic concepts in photography, photography techniques, and the use of the FSP's forensic photography equipment.

7.14.4.1 The trainee shall be able to ~~recite~~describe the properties of light.

7.14.4.2 The trainee shall be able to describe the file types (digital camera) or film types for the camera equipment used by the FSP.

7.14.4.3 The trainee shall be able to define the following: f-stop, shutter speed, aperture, and exposure.

7.14.4.4 The trainee shall be able to explain how changes in the shutter speed and aperture affect exposure.

7.14.4.5 The trainee shall be able to explain the relationship between aperture and depth of field.

7.14.4.6 The trainee shall be able to identify basic camera components: camera body, lens, shutter, diaphragm, and shutter release.

7.14.4.7 If using a digital camera, the trainee shall be able to describe the type of sensor and the resolution settings of the camera.

7.14.4.8 If using a digital camera, the trainee shall be able to explain the relationship of pixels and the resolution settings of the camera.

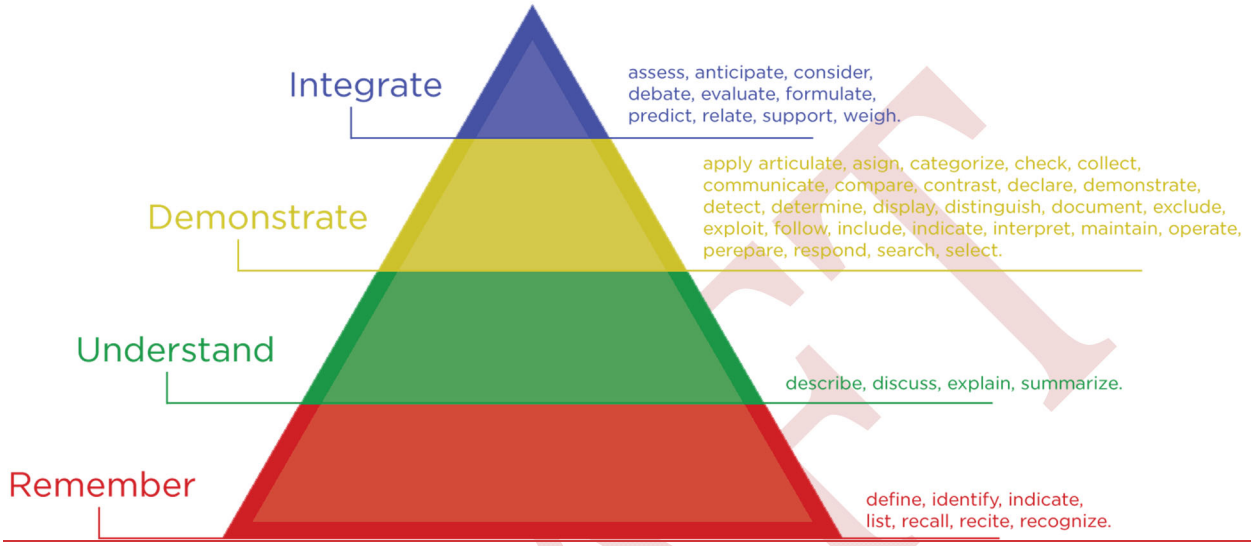
7.14.4.9 The trainee shall be able to demonstrate proper positioning of objects/surfaces and scales in latent print photographs.

7.14.4.10 The trainee shall be able to demonstrate proper lighting techniques for latent print photography.

7.14.4.11 The trainee shall be able to demonstrate appropriate photography methods for latent prints (e.g., macro photography, high contrast photography, reflective photography, and fluorescent photography).

Annex A
(informative)

Bloom's Taxonomy



The levels of comprehension in this training standard: Remember, Understand, Demonstrate, Integrate, are modeled after Blooms Taxonomy. Bloom's Taxonomy was created in 1956 and modified in 2001 as a framework for categorizing educational goals. Bloom's Taxonomy defines 6 levels of comprehension, while this standard has modified that model to four levels of comprehension for easier application among trainers.[a]

[a] https://cft.vanderbilt.edu/guides-sub-pages/blooms-taxonomy/

Annex B
(informative)

Bibliography

The following bibliography is not intended to be an all-inclusive list, review, or endorsement of literature on this topic. The goal of the bibliography is to provide examples of publications addressed in the standard.

7.2 Friction Ridge Skin

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

2] Champod, C., et al. *Fingerprints and Other Ridge Skin Impressions*. 2016. 2nd Edition. CRC Press, New York, Chapter 1

3] Gutierrez-Redomero, E. and C. Alonso-Rodriguez. *Sexual and topological differences in palmprint and ridge density in the Caucasian Spanish population*. 2013. FSI 229, 159.e1-159.e10

4] Kimura, S. et.al. "Comparative investigations of human and rat dermatoglyphics: palmar, plantar and digital pads and flexion creases." *Anatomical Science International.* 2002. 77. 34-46

5] Hallgrimsson, B. and B. Hall, eds*. Variation: A Central Concept in Biology*. 2005. Elsevier, New York

6] Kucken, M. and C. Champod. "Merkel cells and the individuality of friction skin." *Journal of Theoretical Biology*. 2013. 317. 229-237

7] Kucken, M. and A. Newell. "Fingerprint formation." *Journal of Theoretical Biology*. 2005. 235. 71-83

8] Lewontin, R. *Human Diversity.* Scientific American Books. 1995

9] Maceo, A. "Chapter 2 – Anatomy and Physiology of Adult Friction Ridge Skin.". *Fingerprint Sourcebook.* National Institute of Justice, 2011

10] Misimu, Y. and T. Akiyoshi. "Scanning Electron Microscope Structure of the Fingerprint as Related to the Dermal Surface." *The Anatomical Record.* 1984. 208. 49-55

11] Okajima, M. *Dermal and Epidermal Structures of the Volar Skin*. Birth Defects: Original Article Series, 1979. Volume XV, Number 6. 179-198

12] Raser, J. and E. O'Shea. "Noise in Gene Expression: Origins, Consequences, and Control." *Science*. 2005. Vol. 39. 2010 – 2013

13] Silva, L., et al. "Longitudinal and retrospective study has demonstrated morphometric variations in the fingerprints of elderly individuals." *Forensic Science International.* 2016. 259. 41-46

14] Stucker, M., et al. "Interpapillary Lines – The Variable Part of the Human Fingerprint." *Journal of Forensic Science*. 2001. 46(4): 857-861

15] Werthiem, K. "Chapter 3 – Embryology and Morphology.". *Fingerprint Sourcebook*. National Institute of Justice, 2011

7.3 Empirical Observations and Research Findings

16] Abraham, J., et al. "Modern statistical models for forensic fingerprint examinations: A critical review." *Forensic Science International.* 2013. 232. 131-150

17] Ashbaugh, D. *Quantitative-Qualitative Friction Ridge Analysis*. 1999. CRC Press, New York, Chapter II

18] Barnes, J. "Chapter 1 – History." *Fingerprint Sourcebook*. National Institute of Justice, 2011

19] Champod, C. and P. Margot. *Computer Assisted Analysis of Minutia Occurrences on Fingerprints.* Symposium on Fingerprint Detection and Identification. 1995. 306-318

20] Champod, C. and P. Margot. *Analysis of Minutia Occurrences on Fingerprints – The Search for Non-Combined Minutia.* Proceedings of the Meeting of the International Association of Forensic Sciences. 1996. 1-4

21] Champod, C., et al. *Fingerprints and Other Ridge Skin Impressions*. 2016. 2nd Edition. CRC Press, New York. Chapter 2, Appendix A, and Appendix B

22] European Network of Forensic Science Institutes (ENFSI) *Guideline for Evaluative Reporting in Forensic Science*, 2015[b].

23] Federal Bureau of Investigation. The Science of Fingerprints. 1979. U.S. DOJ, U.S. Government Printing Office. Chapters II and III

~~23]~~24] Gutierrez, E. "Biological variability of the minutiae in the fingerprints of a sample of the Spanish population." *Forensic Science International*. 2007. 172. 98-105

~~24]~~25] Gutierrez-Redomero, E., et al. *Distribution of minutiae in the fingerprints of a sample of the Spanish population*. *Forensic Science International*, 2010. 208. 79-90

~~25]~~26] Holt, S. and L.S. Penrose. *The Genetics of Dermal Ridges*. 1968, Chapters 5-7

~~26]~~27] Hutchins, L. "Chapter 5 – Systems of Friction Ridge Classification." *Fingerprint Sourcebook*. National Institute of Justice, 2011

~~27]~~28] International Association for Identification. *Standardization Committee Report*, 1973

~~28]~~29] International Association for Identification. *Resolution VII*, 1979

~~29]~~30] International Association for Identification. *Standardization II Committee Report*, 2010

[b] Available at: http://enfsi.eu/sites/default/files/documents/external_publications/m1_guideline.pdf

~~30~~]31] International Association for Identification. *Resolution 2010-18*, 2010

~~31~~]32] International Association for Identification. *Position Statement on Conclusions, Qualified Opinions, and Probability Modeling*, February 5, 2017

~~32~~]33] Jain, A., et al. "On the similarity of identical twin fingerprints." *Pattern Recognition*. 2002. 35. 2653-2663

~~33~~]34] Lin, C.H., et al. "Fingerprint Comparison I: Similarity of Fingerprints." *Journal of Forensic Science.* April 1982. 27(2):290-304.

~~34~~]35] Lindley, D.V. *Understanding Uncertainty.* 2nd edition. 2014. Chapters 1 and 6, Wiley, Hoboken, NJ.

~~35~~]36] Liu, Y. and S. Srihari. *A Computational Discriminability Analysis on Twin Fingerprints.* Computational Forensics. Proceedings of the Third International Workshop, IWCF 2009, Volume 5718; 43-54

~~36~~]37] MIT: 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"

~~37~~]38] Moore, D.S., G.P. McCabe, and B.A. Craig. *Introduction to the Practice of Statistics*. W. H. 9th edition, MacMillan Learning, 2016, Chapters 1, 2 and 4,

~~38~~]39] Moses, K. "Chapter 6 – AFIS." *Fingerprint Sourcebook*. National Institute of Justice, 2011

~~39~~]40] Neumann, C. et al. *Quantifying the weight of evidence from a forensic fingerprint comparison: A new paradigm*. J. R. Statist. Soc. A 175 (2012) Part 2 371-415

~~40~~]41] Neumann, C. et al. "Operational benefits and challenges of the use of fingerprint statistical models: A field study." *Forensic Science International*. 2011. 212. 32-46

~~41~~]42] Neumann, C. et al. "Quantifying the weight of fingerprint evidence through the spatial relationships, directions, and types of minutia observed on fingermarks." *Forensic Science International*. 2015. 248. 154-171

42]43] Pechenkina, E. et al. "Genetic and Environmental Influence on the Asymmetry of Dermatoglyphic Traits." *American Journal of Physical Anthropology*, 2000

43]44] Ramatowski, R. ed. *Advances in Fingerprint Technology.* 2013. 3rd Edition. CRC Press, New York, Chapter 15

44]45] Swofford, H. et al. "A method for the statistical interpretation of friction ridge skin impressions evidence: Method development and validation." *Forensic Science International*. 2018. 287. 113-126

45]46] Tao, X. et al. *Fingerprint Recognition with Identical Twin Fingerprints.* PLoS ONE 7(4):e35704. doi:10.1371/journal.pone.0035704

7.4 Introduction to Fingerprints

46]47] Champod, C. et al. *Fingerprints and Other Ridge Skin Impressions*. 2016. 2nd Edition. CRC Press, New York. Chapter 2

47]48] Cowger, J. *Friction Ridge Skin: Comparison and Identification*. 1993. CRC Press, Ann Arbor, Chapter 3

48]49] Federal Bureau of Investigation. *The Science of Fingerprints*. 1979. U.S. DOJ, U.S. Government Printing Office, Chapters II and III

7.5 Introduction to Proximal and Medial Phalange Prints

49]50] Cowger, J. *Friction Ridge Skin: Comparison and Identification*. 1993. CRC Press, Ann Arbor, Chapter 3

50]51] Cummins, H. and C. Midlo. *Fingerprints, Palms, and Soles: An Introduction to Dermatoglyphics.* 1976. 3rd Edition. Research Publishing Company, South Berlin, MA

7.6 Introduction to Palm Prints

51]52] Ashbaugh, D. *Quantitative-Qualitative Friction Ridge Analysis*. 1999. CRC Press, New York, Chapter VIII

52]53] Cowger, J. *Friction Ridge Skin: Comparison and Identification*. 1993. CRC Press, Ann Arbor, Chapter 3

53]54] Cummins, H. and C. Midlo. *Fingerprints, Palms, and Soles: An Introduction to Dermatoglyphics*. 1976, 3rd Edition. Research Publishing Company, South Berlin, MA

54]55] Maceo, A. et al. "Palm Prints." *Encyclopedia of Forensic Science*. 2013, 2nd Edition. Elsevier

55]56] Ray, E. "Frequency of Patterns in Palms." *Journal of Forensic Identification*. 2012. 62(6): 568-587

7.7 Introduction to Foot Prints

~~56]~~57] Cowger, J. *Friction Ridge Skin: Comparison and Identification*. 1993. CRC Press, Ann Arbor, Chapter 3

~~57]~~58] Cummins, H. and C. Midlo. *Fingerprints, Palms, and Soles: An Introduction to Dermatoglyphics*. 1976, 3rd Edition. Research Publishing Company, South Berlin, MA, 1976

~~58]~~59] Johnson, D. "The Friction Ridges of the Feet." *Encyclopedia of Forensic Science*. 2013, 2nd Edition. Elsevier

7.8 ~~Fingerprint Classification~~

~~59]1]~~ **Collecting** ~~Federal Bureau of Investigation. The Science of Fingerprints. 1979. U.S. DOJ, U.S. Government Printing Office. Chapters II and III~~

~~1] Hutchins, L. "Chapter 5 – Systems of Friction Ridge Classification." *Fingerprint Sourcebook.* 2011. National Institute of Justice~~

~~7.9~~ Exemplar Prints

60] Cutro, B.T. "Chapter 4 – Recording Living and Post-Mortem Friction Ridge Exemplars." *Fingerprint Sourcebook.* 2011. National Institute of Justice

61] Cowger, J. *Friction Ridge Skin: Comparison and Identification*. 1993. CRC Press, Ann Arbor. Chapter 2

7.~~10~~9 Examination Method

62] Alcaraz-Fossoul, J. et al., "Fingermark ridge drift." *Forensic Science International*. 2016. (258): 26-31

63] Ashbaugh, D. *Quantitative-Qualitative Friction Ridge Analysis*. 1999. CRC Press, New York. Chapter 4

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

65] Champod, C. et al. *Fingerprints and Other Ridge Skin Impressions*. 2016, 2nd Edition). CRC Press, New York

66] Department of Justice. *Approved Uniform Language for Testimony and Reports for the Forensic Latent Print Discipline*. 2018

67] Expert Working Group on Human Factors in the Analysis of Latent Prints. *Latent Print Examination and Human Factors: Improving Practice through a Systems Approach*. National Institute of Standards and Technology, 2012

68] Holyoak, K. and R. Morrison, eds. *The Cambridge Handbook of Thinking and Reasoning*. Cambridge University Press, 2005

69] Home Office Center for Applied Science and Technology (CAST). *Fingerprint Visualization Manual*. 2014. Center for Applied Science and Technology, London

70] Kent, T. "Water content of latent prints – Dispelling the myth." *Forensic Science International*. 2016. (266): 134-138

71] Langenburg, G. *A Critical Analysis and Study of the ACE-V Process*. 2012. University of Lausanne PhD Thesis

72] Langenburg, G. "Deposition of Bloody Friction Ridge Impressions." *Journal of Forensic Identification.* 2008. (58)3: 355 – 389

73] Lindley, D.V. *Understanding Uncertainty*. 2014, 2nd edition. Chapters 1 and 6, Wiley, Hoboken, NJ, 2014

74] Maceo, A. "Qualitative Assessment of Skin Deformation – A Pilot Study." *Journal of Forensic Identification*. 2009. 59(4): 390 – 440, 2009

75] Neumann, C. et al. "Operational benefits and challenges of the use of fingerprint statistical models: A field study." *Forensic Science International.* 2011. 212, 32-46

76] Praska, N. and G. Langenburg. "Reactions of latent prints to exposed blood." *Forensic Science International.* 2013. (224): 51-58

77] Ramatowski, R. ed. *Advances in Fingerprint Technology*. 2013, 3rd Edition. CRC Press, New York

78] OSAC, Training Guidelines for Video Analysis, Image Analysis and Photography.

79] OSAC Standard for Examining Friction Ridge Impressions
https://www.nist.gov/system/files/documents/2020/10/02/OSAC%20FRS%20EXAMINATION%20STANDARD_Final_Sept2020.pdf

80] OSAC Best Practice Recommendation for Analysis of Friction Ridge Impressions
https://www.nist.gov/system/files/documents/2020/10/02/OSAC%20FRS%20Analysis%20BPR_Final_Sept2020.pdf

81] OSAC Best Practice Recommendation for Comparison and Evaluation of Friction Ridge Impressions
https://www.nist.gov/system/files/documents/2020/10/02/OSAC%20FRS%20Comparison-and-Evaluation%20BPR_Final_Sept2020.pdf

~~78]~~82] OSAC Best Practice Recommendation for Verification in Friction Ridge Examination
https://www.nist.gov/system/files/documents/2020/03/23/OSAC%20FRS%20VERIFICATION%20Document%20Template%202020_Final.pdf

~~79]~~83] Vanderkolk, J. *Forensic Comparative Science*. 2009. Elsevier Academic Press, London, Chapter 6

~~80]~~84] Wertheim, P. "Detection of forged and fabricated latent prints." *Journal of Forensic Identification*. 1994. 44(6): 652-681

81]85] Yamashita, B. and M. French. "Chapter 7 – Latent Print Development." *Fingerprint Sourcebook.* 2011. National Institute of Justice

7.~~11~~10 Performance Studies

82]86] Busey, T. and J. Vanderkolk. *Behavioral and electrophysical evidence for configural processing in fingerprint experts*. Vision Research, 2005

83]87] Busey, T. and F. Parada. "The nature of expertise in fingerprint examiners." *Psychonomic Bulletin & Review*. 2010 17(2): 155-160

84]88] Busey, T., et al. "Consistency and variability among latent print examiners as revealed by eye tracking methodologies." *Journal of Forensic Identification*. 2011

85]89] Executive Office of the President, President's Council of Advisor's on Science and Technology (PCAST), Panel on Forensic Science. *Forensic Science in Criminal Courts: Ensuring Scientific Validity of Feature Comparison Methods*. 2016

86]90] Hicklin, A. *Improving the Rigor of the Latent Print Examination Process*. University of Lausanne PhD Thesis, 2017

87]91] Langenburg, G. *A Critical Analysis and Study of the ACE-V Process*. University of Lausanne PhD Thesis, 2012.

88]92] Neumann, C. et al. *Improving the Understanding and the Reliability of the Concept of Sufficiency in Friction Ridge Examination*. NIJ, 2013

89]93] Pacheco, I. et al. *Miami Dade Research Study for the Reliability of the ACE-V Process: Accuracy & Precision in Latent Fingerprint Examinations*. NIJ, 2014

90]94] Tangen, J. et al. *Identifying fingerprint expertise*. Association for Psychological Science. 2011

91]95] Ulery, B. et al. "Factors associated with latent fingerprint exclusion determinations." *Forensic Science International*. 2017 (275): 65-75

92]96] Wilkinson, D. et al. "Expert Fingerprint Testimony Post-PCAST – A Canadian Case Study." *Journal of Forensic Identification*. 2018. 86(3).

7.~~12~~11 Human Factors and Quality Assurance

93]97] Black, J. "Evaluating the extent and scope of "verification" in analysis, comparison, and verification (ACE-V)." *Wiley Encyclopedia of Forensic Science*. 2009. John Wiley & Sons, Chichester

94]98] Biederman, A. et al. "Decision theoretic properties of forensic identification: Underlying logic and argumentative implications." *Forensic Science International*. 2008. (177):120-132

95]99] Busey, T., et al. "The impact of fatigue on latent print examinations as revealed by behavioral and eye gaze testing." *Forensic Science International.* 2015

100] Clarie, A. J., et al. "The forensic confirmation bias: A comparison between experts and novices". Journal of Forensic Sciences. 2019

101] Cooper, G., Meterko, V. "Cognitive bias research in forensic science: A systematic review". Forensic Science International. 2019

~~96]~~102] Expert Working Group on Human Factors in the Analysis of Latent Prints. *Latent Print Examination and Human Factors: Improving Practice through a Systems Approach*. National Institute of Standards and Technology, 2012

~~97]~~103] Langenburg, G. *A Critical Analysis and Study of the ACE-V Process*. University of Lausanne PhD Thesis, 2012

~~98]~~104] Neumann, C. et al. *Improving the Understanding and the Reliability of the Concept of Sufficiency in Friction Ridge Examination*. NIJ, 2013

~~99]~~105] Schiffer, B. and E. Stauffer. "Accreditation: Organizational." *Wiley Encyclopedia of Forensic Science*. 2009. John Wiley & Sons, Chichester

~~100]~~106] Scottish Government. *The Fingerprint Inquiry Report*, APS Group Scotland, 2011

~~101]~~107] U.S. Department of Justice Office of Inspector General. *A Review of the FBI's Handling of the Brandon Mayfield Case*. Office of Inspector General. Oversight and Review Division, 2006

7.~~13~~12 Testimony

~~102]~~108] American Association for the Advancement of Science. *Forensic Science Assessments: A Quality and Gap Analysis – Latent Fingerprint Examination.* Washington, D.C. 2017

~~103]~~109] Champod, C. *Fingerprint Identification: Advances since the 2009 National Research Council Report.* Philosophical Transactions B of the Royal Society. 370: 20140259

~~104]~~110] Chisum, J. and B. Turveyt. Crime Scene Reconstruction. Elsevier Academic Press, 2007, Chapter 13

~~105]~~111] Edmond, G. et al. "A guide to interpreting forensic testimony: Scientific approaches to fingerprint evidence." *Law, Probability & Risk*. 2014. 13(1): 1-25

~~106]~~112] Edmond, G. et al. "How to cross-examine forensic scientists: A guide for lawyers." *Australian Bar Review*. 2014. (39):174-197

~~107]~~113] Executive Office of the President, President's Council of Advisor's on Science and Technology (PCAST), Panel on Forensic Science. *Forensic Science in Criminal Courts: Ensuring Scientific Validity of Feature Comparison Methods*, 2016

~~108]~~114] Executive Office of the President, President's Council of Advisor's 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, 2017

~~109]~~115] Foster, K. and P. Huber. *Judging Science: Scientific Knowledge and the Federal Court*. The MIT Press, Cambridge, 1999

~~110~~]116] Girod, A., et al. "Fingermark age determinations: Legal considerations, review of the literature and practical propositions." *Forensic Science International*. (262): 212-226

~~111~~]117] Golan, T. *Laws of Men and Laws of Nature: The History of Scientific Expert Testimony in England and America*. Harvard University Press, Cambridge, 2004

~~112~~]118] Moenssens, A. "Cross-examination of experts." *Wiley Encyclopedia of Forensic Science.* 2009. John Wiley & Sons, Chichester

~~113~~]119] Moenssens, A. "Direct examination of experts." *Wiley Encyclopedia of Forensic Science*, 2009. John Wiley & Sons, Chichester

~~114~~]120] Moenssens, A. "Ethics: Codes of conduct for expert witnesses." *Wiley Encyclopedia of Forensic Science*. 2009. John Wiley & Sons, Chichester

~~115~~]121] Moenssens, A. "Expert witness: Who is?." *Wiley Encyclopedia of Forensic Science*. 2009. John Wiley & Sons, Chichester

~~116~~]122] Moenssens, A, B. DesPortes, and C. Edward eds. *Scientific Evidence in Civil and Criminal Cases*. 2013, 6th Edition. Foundation Press, New York

~~117~~]123] Moenssens, A. and S. Meagher. "Chapter 13 – Fingerprints and the Law." *Fingerprint Sourcebook*. 2011. National Institute of Justice

~~118~~]124] National Academy of Sciences. *Strengthening Forensic Science in the United States: A Path Forward*. 1999. National Research Council

~~119~~]125] Pozner, L. and R. Dodd. *Cross Examination: Science and Techniques*. 2018, 3rd Edition. LexisNexis, New York

~~120~~]126] Steele, L. "The defense challenge to fingerprints." *Criminal Law Bulletin.* 2004. 40(3): 213-240

127] OSAC Best Practice Recommendation for Testimony Monitoring https://www.nist.gov/system/files/documents/2020/10/02/OSAC%20FRS%20TESTIMONY%20MONITORING_Final_Sept2020.pdf

7.~~14~~13 Automated Biometric Identification Systems

~~121~~]128] ANSI/NIST-ITL 1-2011 Update: 2015, *Data Format for the Interchange of Fingerprint & other Biometric Information, NIST Special Publication 500-290e3*, 2015. National Institute of Standards and Technology, Washington, DC

~~122~~]129] Busey, T. et al. "The relation between sensitivity, similar non-matches and database size in fingerprint database searches." *Law, Probability, and Risk*. 2014. 13, 151-168

~~123~~]130] Criminal Justice Information Services, *Electronic Biometric Transmission Specification (EBTS)*, 2013. version 10.0, Federal Bureau of Investigation, Clarksburg, WV

~~124~~]131] Chapman, W. et al. *Latent Interoperability Transmission Specification, NIST Special Publication 1152*, 2013. National Institute of Standards and Technology, Washington, DC

~~125]~~132] Chapman, W. et al. *Markup Instructions for Extended Friction Ridge Features, NIST Special Publication 1151*, 2013. National Institute of Standards and Technology, Washington, DC

133] Itiel E. Dror & Jennifer Mnookin, "The use of technology in human expert domains: challenges and risks arising from the use of automated fingerprint identification systems in forensic science," 9 Law, Probability, & Risk 47 (2010)

134] Itiel E. Dror et al., "The Impact of Human Technology Cooperation & Distributed Cognition in Forensic Science: Biasing Effects of AFIS Contextual Information on Human Experts," 57 Journal of Forensic Science 343, 351 (2012)

~~126]~~135] Komarinski, P. *Automated Fingerprint Identification Systems (AFIS),* 2005. Elsevier Academic Press, New York

~~127]~~136] Moses, K. "Chapter 6 – AFIS." *Fingerprint Sourcebook*. 2011. National Institute of Justice

7.~~15~~14 Latent Print Processing

~~128]~~137] Champod, C. et al. *Fingerprints and Other Ridge Skin Impressions*. 2016, 2nd Edition. CRC Press, New York

~~129]~~138] Home Office Center for Applied Science and Technology (CAST). *Fingerprint Visualization Manual*. 2014. Center for Applied Science and Technology, London

~~130]~~139] Kent, T. "Water content of latent prints – Dispelling the myth. *Forensic Science International*. 2016. (266): 134-138

~~131]~~140] Ramatowski, R. ed. *Advances in Fingerprint Technology.* 2013. CRC Press, New York

~~132]~~141] Yamashita, B. and M. French. "Chapter 7 – Latent Print Development." *Fingerprint Sourcebook*. 2011. National Institute of Justice

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