OSAC Standard Framework for Developing Discipline Specific Methodology for ACE-V

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Organization of Scientific Area Committees (OSAC) for Forensic Science

OSAC Proposed Framework

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Prepared by
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This document has been developed by the Virtual Subcommittee #3 of the Organization of Scientific Area Committees (OSAC) for Forensic Science through a consensus process and is *proposed* for further development through a Standard Developing Organization (SDO). This document is being made available so that the forensic science community and interested parties can consider the recommendations of the OSAC pertaining to applicable forensic science practices. The document was developed with input from experts in a broad array of forensic science disciplines as well as scientific research, measurement science, statistics, law, and policy.

This document has not been published by a SDO. Its contents are subject to change during the standards development process. All interested groups or individuals are strongly encouraged to submit comments on this proposed document during the open comment period administered by ASTM International (www.astm.org).

BACKGROUND

This multi-part document aims to establish a standard framework and minimum requirements for developing discipline specific standards for the methodology of ACE-V. ACE-V is an acronym for the Analysis, Comparison, Evaluation and Verification methodology used by forensic practitioners primarily when conducting feature comparisons.

The OSAC Virtual Subcommittee #3, ACE Process Map, was established on 03/03/2016 and was tasked to develop such a framework.

Champod[1] states that pioneers in forensic science, although not named that way, were already applying a protocol similar to ACE-V, citing (Heindl 1927[2] and Locard 1931[3]). He recognizes the Royal Canadian Mounted Police (RCMP) as "…the organization that developed and adopted the ACE-V protocol for forensic comparisons…" referencing (Huber 1959[4], 1972[5]). Chief Supt. R.A. Huber in 1972, primarily addressed forensic document examiners with this publication. He was the Assistant Director, Laboratories and Identification Directorate, R.C.M.P. in Ottawa at the time. He recognized that various disciplines are following a similar process even though mostly subconsciously, e.g. in handwriting and firearms examinations. He also mentioned fingerprint, physical matching and chemical examinations. He described the three distinct phases of the ACE methodology as follows:

- "Analysis – The unknown item must be reduced to a matter of its properties or characteristics, which may be directly observable, measurable, or otherwise perceptible qualities.
- Comparison – The properties or characteristics of the unknown determined through Analysis are now compared with the familiar or recorded properties of known items.
- Evaluation – Similarities or dissimilarities in properties or characteristics will each have a certain value for identification purposes determined by its likelihood of occurrence. The weight or significance of each must therefore be considered."

Further on p.11 Huber stated: "*Scientific method provides a fundamental criterion for conclusions drawn from it: that conclusions must be restricted to what one may expect to be the conclusions of any other competent scientist*", inferring what later became known as the "Verification" phase of ACE-V.

This methodology was also adopted by Cassidy[6] in the Footwear discipline in his publication in 1980. He added however that: "The inexperienced examiner should always have his

[1] Champod, C. Lennard, C., Margot, P., Stoilovic, M. (2016). *Fingerprints and Other Ridge Skin Impressions, Second Edition.* Boca Raton, FL: CRC Press, Taylor & Francis Group, Chapter 2, p. 34.

[2] Heindl, R. (1927). *System und Praxis der Daktyloskopie, 3rd ed*. Berlin Germany: Walter de Gruyter & Co., Vereinigung Wissenschaftlichen Verleger.

[3] Locard, E. (1931). *Traité de criminalistique vol. I à VII.* Lyon, France: Joannès Desvigne et fils Editeurs.

[4] Huber, R. A. (1959). Expert Witnesses. *Crim. Law Q., 2*, pp. 276-295.

[5] Huber, R. A. (1972, July-August). The Philosophy of Identification. *RCMP Gaz.*, pp. 9-14.

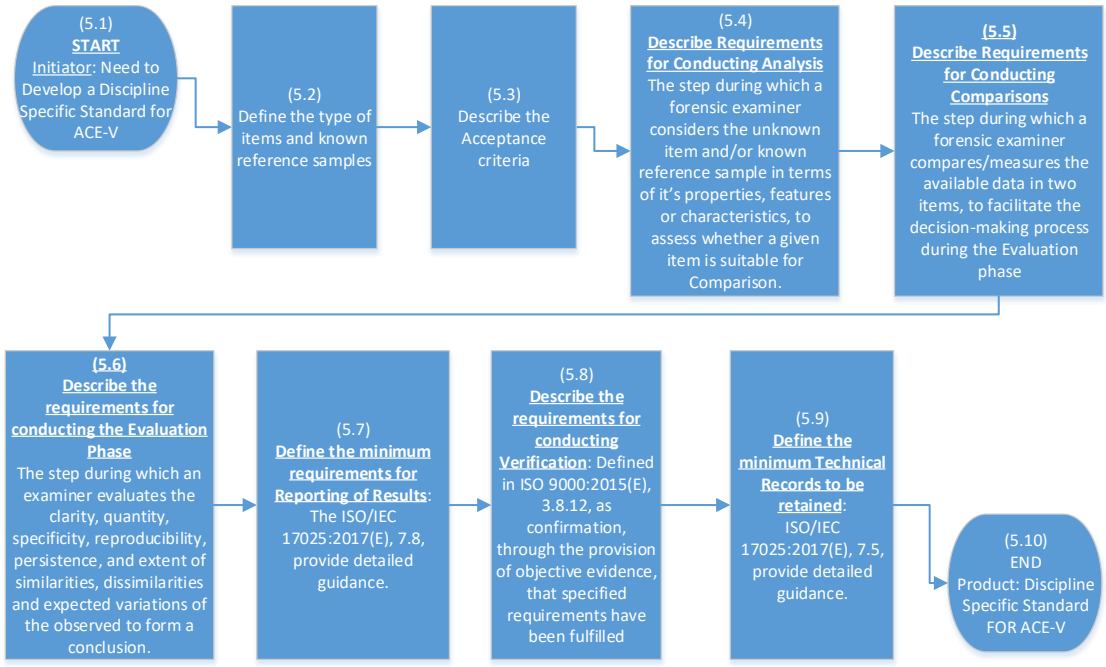
[6] Cassidy, M. J. (1980). Footwear Identification. *Public Relations Branch of the Royal Canadian Mounted Police*, pp. chapter 5, p. 91.

identification work re-examined and confirmed by a qualified person", re-enforcing the Verification concept.

David Ashbaugh published several articles in the early 1990's covering the methodology of ACE-V for friction ridge comparison and extensively so in his publication in 1999[7]. ACE-V was adopted by the Scientific Working Group for Friction Ridge Analysis, Study, and Technology (SWGFAST)[8] in 2002 as the standard for friction ridge examination.

John Vanderkolk discusses the application of ACE-V for Image Analysis, in great detail in his publication: Forensic Comparative Science. Forensic Comparative Science: Qualitative Quantitative Source Determination of Unique Impressions, Images, and Objects, published in 2009[9]. ACE-V was cited as a commonly accepted protocol applied to photographic comparisons in the 2013 SWGIT best practices document (SWGIT Section 16)[10]. It was also published in 2015 in the Best Practice Manual for Fingerprint Examination issued by the European Network of Forensic Science Institutes (ENFSI)[11].

HIGH LEVEL FRAMEWORK FOR DEVELOPING DISCIPLINE SPECIFIC STANDARDS FOR ACE-V



[7] Ashbaugh, D. R. (1999). *Qualitative-Quantitative Friction Ridge Analysis-An Introduction to Basic and Advanced Ridgeology.* Boca Raton, FL: CRC Press.

[8] Scientific Working Group for Friction Ridge Analysis, Study, and Technology (SWGFAST). (03/13/2013). *Document #10 Standards for Examining Friction Ridge Impressions and Resulting Conclusions.*

[9] Vanderkolk, John, *Forensic Comparative Science: Qualitative Quantitative Source Determination of Unique Impressions, Images, and Objects*, Academic Press, 20th July 2009.

[10] Scientific Working Group on Imaging Technology (SWGIT), *Section 16 Best Practices for Forensic Photographic Comparison*

[11] ENFSI. (2015, November). Best Practice Manual for Fingerprint Examination, ENFSI-BPM-FIN-01, Version 01. Chapter 6, p.13-16.

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1. PURPOSE

This framework document impact and applies to forensic disciplines that identify the need to develop discipline specific standards for the application of the methodology of ACE-V (Analyze, Compare, Evaluate and Verify).
Application of the requirements in this document will lead to inter disciplinary standardized methodology which can then be validated through empirical studies within each of the various forensic disciplines involved in conducting feature comparisons.

2. SCOPE

This document identifies and defines the various phases within the methodology of ACE-V.
It specifies minimum general requirements that shall be adhered to for a methodology to be recognized as ACE-V.
It is the intent that each discipline, considering the implementation of the ACE-V methodology, develop a series of discipline specific ACE-V standards, to govern the methods used to conduct the various phases of ACE-V.
The application of the methodology of ACE-V is initiated when an unknown item is introduced into the forensic process with the objective of determining the specific type or possible source of the unknown item, and is complete when a verified conclusion is reached regarding the specific type or possible source of the unknown item.

3. TERMS AND DEFINITIONS

For purposes of this document, the following definitions apply:

3.1. ***Item*** **-** Object, substance or material that is collected, derived or sampled as part of the *forensic process as defined in ISO 21043-1:2018(E)*[12]

3.2. ***Reference sample*** - Material from a known source used for comparison purposes in a forensic process *ISO 21043-1:2018(E)*[13]

NOTE: **Source** may refer to a specific person (for example, an individual whose face appears in an image, a recorded voice, or a sample of handwriting); a specific part of the body of an individual (for example, the finger that produced a latent print); a specific object (for example, a firearm, a shoe, or a typewriter); or a location (for example, a building visible in the background of an image).

3.3. **Verification** - Confirmation, through the provision of *objective evidence* that specified *requirements* have been fulfilled[14]

[12] ISO 21043-1:2018(E), 3.19
[13] ISO 21043-1:2018(E), 3.25
[14] ISO 9000:2015 (E), 3.8.12

4. GENERAL REQUIREMENTS

4.1. Discipline specific standards for ACE-V shall be developed following the framework of this document, and methods and criteria applied in each step shall be clearly defined.

4.2. ISO 9001: 2015[15] provides direction on the Quality management systems requirements for design and development of products and services, specifically in clause 8.3.4 with regards to design and development controls such as verification and validation. Methods selected for inclusion in the discipline specific standard shall provide information regarding the validation of such methods. Those methods that will be used in Testing Laboratories, shall adhere to the method verification and validation requirements as per ISO/IEC 17025[16].

5. PROCESS REQUIREMENTS: Developing Discipline Specific Standards for Ace-V

5.1. **Initiator:** The process described in this framework document is initiated when the need exists to Develop a Discipline Specific Standard for ACE-V.

5.2. **Define the type of items and known reference samples** that will be accepted for testing in the specific discipline.

NOTE 01: Examples of items are: Hinge lifters or digital images containing friction ridge impressions, electrostatic dust lifts or three-dimensional casts containing footwear impressions.

5.3. **Describe the Acceptance criteria**: Each discipline specific standard shall describe the minimum acceptance criteria to which the items must adhere before being accepted for testing.

NOTE 01: Examples of acceptance criteria are clarity of digital images, minimum resolution requirements for digital images, proper packaging to prevent contamination and cross contamination, minimum quality requirements for known reference samples.

5.4. **Describe Requirements for Conducting Analysis:** Analysis is a step in the ACE-V Methodology during which a forensic examiner considers the unknown item and/or known reference sample in terms of its properties, features, or characteristics, which may be directly observable, measurable, or otherwise perceptible qualities, to assess whether a given item is suitable for potential Comparison. Each discipline specific standard shall at a minimum, clearly define and describe the following aspects of the Analysis step:

5.4.1. Define measurable, observable, demonstrable data, features or characteristics that will be considered to provide objective evidence that the specified requirement to reach a suitability decision has been met.

NOTE: Examples of features are class characteristics in footwear comparisons, different levels of detail in the friction ridge impressions or striations on cartridge casings that will be considered during comparisons.

5.4.2. The specific methods to be used during the Analysis step.

NOTE 1: Examples of methods for analysis are visual examination of items under different levels of magnification, microscopy, spectrometry and micrometry to detect features or characteristics that can be utilized for comparison. Application of automated database searches to detect features and apply suitability values.

[15] ISO 9001: 2015, 8.3

[16] ISO/IEC 17025:2017(E), 7.2, **Selection, verification and validation of methods**.

5.4.3. The criteria to apply to determine the specified requirement to reach a suitability decision.

5.5. **Describe the Requirements for Conducting Comparisons:** Comparison is a step in the ACE-V Methodology during which a forensic examiner compares/measures the available data (properties, features, or characteristics, which may be directly observable, measurable, or otherwise perceptible qualities) in two items, to facilitate the decision-making process during the Evaluation phase. Each discipline specific standard shall clearly define and describe at a minimum, the following aspects of the Comparison step:

5.5.1. The specific methods to be used during the Comparison step.

NOTE: Examples of methods of comparison include using a comparison microscope in firearms examination, visual side by side comparison in friction ridge examination, mass spectrometry, creating overlays in footwear comparison. Also automated systems like "Case specific Biometric Databases" to conduct comparisons with small populations of known reference samples.

5.5.2. The instruments used during the Comparison step, and where applicable, minimum manufacturing and calibration requirements for specific instruments.

5.6. **Describe the requirements for conducting the Evaluation Phase:** Evaluation is a step in the ACE-V Methodology during which an examiner evaluates the clarity, quantity, specificity, reproducibility, persistence, and extent of similarities, dissimilarities and expected variations of the observed data (properties, features, or characteristics, which may be directly observable, measurable, or otherwise perceptible qualities), taking into account any potential limitations of the items, to form a conclusion. Each discipline specific standard shall clearly define and describe at a minimum, the following aspects of the Evaluation step:

5.6.1. The method/s to be used during the Evaluation step for interpreting data/weighing the observations.

NOTE 1: For example, for source conclusions, the examiner assesses the weight of observations by considering the prospect of finding the observed characteristics if the items came from the same source, as well as the prospect of finding the observed characteristics if the items came from different sources. When the examiner is reaching a categorical conclusion, such as "identification" or "exclusion," **it is important that standards specify not only the factors to be weighed but also the threshold/criteria for reaching each possible conclusion**.

NOTE 2: This should include the application of statistical models where applicable.

5.6.2. The range of possible conclusions and the criteria to apply to determine the specified requirement to reach a specific conclusion.

5.6.3. Specify the circumstances (if any) under which it is appropriate to consider contextual information or investigative facts when drawing conclusions.

5.7. **Define the minimum requirements for Reporting of Results:**

5.7.1. ISO/IEC 17025:2017(E), 7.8, provide detailed guidance on Reporting requirements.

5.8. **Define the minimum Technical Records to be retained**:

5.8.1. ISO/IEC 17025:2017(E), 7.5, provide detailed guidance on requirements for Technical Records.

5.8.2. At a minimum documentation should include in some manner the features observed in each of the items to be compared.

5.8.3. Identify contextual information about matters other than the physical characteristics of the items being compared, that should be included in the documentation.

5.8.4. Specify those steps in a procedure where the sequence of the steps is critical to the outcome of the test and define the minimum requirements for documentation to be retained in the Technical record in this regard. For example, this is particularly relevant where the discipline applies bias reduction procedures such as "linear-ACE-V" or "linear sequential unmasking" to reduce bias.

5.9. **Describe the requirements for conducting Verification**: Verification is defined in ISO 9000:2015(E), 3.8.12, as the confirmation, through the provision of *objective evidence*, that specified *requirements* have been fulfilled. It is further defined in ISO/IEC 17025:2017(E), 3.8, for testing and calibration Laboratories as: "provision of objective evidence that a given item fulfils specified requirements. "Item" is further described in Note 2 to entry: "The item may be, for example, a process, measurement procedure, material, compound, or measuring system. Each discipline specific standard shall clearly define and describe at a minimum, the following aspects of the Verification Step:

5.9.1. The various methods through which confirmation is obtained. ISO 9000:2015(E), 3.8.12 in Note 1 to entry, describes the process of confirmation as follows: "…The objective evidence needed for a verification can be the result of an *inspection* (3.11.7) or of other forms of *determination* (3.11.1) such as performing alternative calculations or reviewing *documents* (3.8.5)…". Documents are further defined in 3.8.5 as: "…*information* (3.8.2) and the medium on which it is contained…"

5.9.2. What would constitute objective evidence that the specified requirements have been met. 3.8.3, defines objective evidence as: "…*data* (3.8.1) supporting the existence or verity of something…" and in Note 1 to entry indicates that: "…Objective evidence can be obtained through observation, *measurement* (3.11.4), *test* (3.11.8), or by other means…"

5.9.3. The specified requirements to be met for each result or conclusion. ISO 9000:2015(E), 3.6.4 defines "requirement" as: "…need or expectation that is stated, generally implied or obligatory…". In Note 2 to entry it further states that: "…A specified requirement is one that is stated, for example in *documented information* (3.8.6) …".

5.10. **End**: The process described in this framework document ends when a Discipline Specific Standard for ACE-V is complete.

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