## B155 A Review of the Scientific Foundations for Firearm Examination

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**Learning Overview:** After attending this presentation, attendees will be able to comprehend the wide range of results obtained for measurement of error rate in firearm examinations and the large number of influence factors on those results.

**Impact on the Forensic Science Community:** This presentation will impact the forensic science community by enabling attendees to derive an improved understanding of the scientific bases underlying firearm examination, its current state of the art, and its future directions.

Forensic science plays a vital role in the criminal justice system by providing scientifically based information through the analysis of physical evidence. Several scientific advisory bodies have expressed the need for scientific foundation reviews of forensic science disciplines, and the National Institute of Standards and Technology (NIST) has been tasked as an appropriate agency for conducting them. A scientific foundation review is a study that seeks to document and evaluate the foundations of a scientific discipline; that is, the trusted and established knowledge that underpins the discipline's methods. These reviews seek to answer the question: "What empirical data exist to support the methods that forensic science practitioners use to analyze evidence?" The purpose of a scientific foundation review is to document and consolidate information supporting the methods used in forensic analysis and identify knowledge gaps where they exist. This presentation will enable attendees to comprehend the wide range of results obtained for measurement of error rate in firearm examination and the large number of influence factors on those results.

NIST began by developing a general specification for these reviews, then undertook its first one, a review of DNA mixtures, now nearly complete.[1] Subsequently, NIST initiated reviews of bitemark analysis and digital evidence.

The review of Scientific Foundations for Firearm Examination, begun in October 2019, is the fourth in the series. The project team is evaluating a wide body of published literature and other materials devoted to firearm examination. A bibliography database has been developed containing 690 references (as of October 2020). Among other topics, the review includes historical perspectives of the field and current methods in use, key takeaways and considerations for the field, and studies of the advanced methods of 3D acquisition and objective algorithmic analyses, but the primary emphasis is placed on the scientific foundations of comparison microscopy, which has been the most widely used method by far.

Toward this end, all known literature and materials that contain studies of error rates for identification and exclusion of matching bullets and cartridge cases have been included with a focus on 29 reports of interlab studies, method validations, and proficiency tests. As suggested in the PCAST report, these works may be classified into three categories: (1) "open, independent" studies such as that by Baldwin et al., wherein each question posed is independent of the others; (2) "open, dependent" studies, such as that by Smith et al., wherein each decision changes the *a priori* probability of other decisions; and (3) "closed" studies, wherein every questioned unknown has a true match in the set.[2-4]

In addition, six other factors are specified that influence the values of measured error rates. These include: (1) the region of interest (bullet land engraved area, breech face impression, etc.); (2) the study size (equal to the number of questions multiplied by the number of participants); (3) whether or not known pairs are included as examples and standards; (4) whether or not the study includes consecutively manufactured firearms; (5) whether questions are declared to participants or covertly included in case work; and (6) test difficulty.

The core team includes ten people, but others in the firearm examination community would be welcome to serve as a resource group of ideas and feedback to the team.

**Reference(s):**

1. *NIST Scientific Foundation Reviews NISTIR 8225 Draft*. 2018, National Institute of Standards and Technology: Washington, DC. p. 31.
2. PCAST (President's Council of Advisors on Science and Technology). *Report to the President: Forensic Science in Criminal Courts: Ensuring Scientific Validity of Feature-Comparison Methods*, Executive Office of the President, Editor. 2016, The White House: Washington, DC. p. 174.
3. Baldwin, D.P., et al. *A Study of False-Positive and False-Negative Error Rates in Cartridge Case Comparisons*. 2014, Defense Technical Information Center.
4. Smith, T.P., G.A. Smith, and J.B. Snipes. A Validation Study of Bullet and Cartridge Case Comparisons Using Samples Representative of Actual Casework. *Journal of Forensic Sciences* 3, 2016. 61(4): p. 939-946.

**Firearm, Examination, Foundation**



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