



B173 Challenges in Developing Objective Interpretation Methods for Firearm and Tool Mark Examination

Robert M. Thompson, BS, NIST, Special Programs Office-Forensic Sciences, 100 Bureau Drive, MS 8102, Gaithersburg, MD 20899*

After attending this presentation, attendees will appreciate some of the major challenges in developing objective interpretation models in support of the subjective conclusions in firearm and tool mark comparison examinations.

This presentation will impact the forensic science community by exposing some of the scientific, technological, and training hurdles to be overcome before 2D and 3D tool mark surface comparisons are accepted in court.

Over the past few years, the broad scientific disciplines that make up the “Forensic Sciences” have experienced an accelerated interest in developing scientifically validated and rigorous methods to objectively measure examination results to augment the examiner’s subject-based conclusion or opinion. The impression pattern disciplines currently are the greatest focus of such research due to the fact that examination results are fundamentally cognitively constructed by the examiner’s observation skill, training, and experience. Firearm and tool mark examination and identification is a field in which objective measurement of the similarity of tool mark surfaces would be valuable to assist the examiner in supporting or refining the ultimate conclusion in examinations. This Research and Development (R&D) effort has been greatly assisted by increased resolution of digital photomicrography, instruments that measure 3D topographical micro-surface topography, and modern computational hardware and software; however, there are important challenges and obstacles that have to be addressed before a successful presentation of evidence, analysis, and expert opinion are delivered in a courtroom. This presentation will review what are believed to be the primary future challenges.

Technological: The forensic science profession is a small market compared to other commercial interests; the tool mark profession is even smaller. The instrumentation used in the nascent 2D imaging and 3D topographical comparison systems must be engineered by companies who have an interest in ultimately selling their systems in the future. The instrument manufacturers also must be convinced of the value in employing international standards in file transfer/sharing so that interoperability is baked into their technology from the onset. Additionally, each system brings performance strengths and weaknesses so it is probable that a number of objective comparison schemes must be tested and validated.

Measurement of Error and Confidence: Objective measurement of similarity necessarily must be paired with an objective conclusion of source. The conclusion may be based on an empirically derived threshold where identification of source is supported or based on the measured similarity quantity in relation to numerous known non-match comparisons where any similarity is due to chance. Both of these approaches require statistically valid databases of fired bullets and casings where the ground truth is known. Additionally, the databases must be adequately large and represent differences in caliber, ammunition materials, and firearm production types typical to those submitted to crime laboratories. For any determination of error rate, random match, confidence, or likelihood ratio, very large databases are warranted so that any of these results are scientifically valid.

Training: The examiners must be trained with the new technology so they are comfortable with foreign concepts and protocols such as objective measurement of tool mark similarity, how that is accomplished, the mathematical/statistical underpinnings of the comparison and the results, and how the statistical weight and measurement of confidence in a comparison is reported and best testified to a lay jury. Some thought and research on how to “model” accurate communication of these principles for testimony is required. Training the legal profession and judges in these “new” methods may be lacking and only conveyed in adversarial court settings in many jurisdictions. Having a robust and vigorously validated technology and method for casework is necessary for a successful adoption of the future tool mark comparison methods.

Objective Comparison, Firearm and Tool Mark, Similarity Measurement