B36 A Framework for Firearm Tool Mark Population Statistics

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After attending this presentation, attendees will better understand a potential pathway toward developing firearm tool mark population statistics.

This presentation will impact the forensic science community by providing a potential statistical framework for reporting error rates in firearms and tool mark identifications.

The population statistics describe the frequency distributions of a similarity score for, respectively, same-source comparisons and different-source comparisons of ballistic samples, such as cartridge cases and bullets. Similar to DNA analysis, these distributions are needed to establish a statistical foundation for the estimation of identification confidence limits and error rates. An important component of the proposed research is to systematically evaluate, for different firearm populations, the effects of key processing parameters on the comparison score distributions and associated error rate estimates. Conducting this research will play an important role in determining the extent to which the comparison protocol, population statistics, and error rate estimation need to be tailored to a particular firearm subpopulation.

Firearms from five manufacturers were chosen for this research. These include a minimum of 50 firearms each from Sig Sauer®, Ruger, Smith and Wesson®, Glock®, and Colt®. The breechface impression on 568 test-fired cartridge cases were measured from 284 firearms. Distributions for known match and known non-match comparison scores were generated for all the samples, for each firearm model, and for each breechface class characteristic. Furthermore, the effects of key processing parameters on these distributions were evaluated. The distributions were applied to estimate the respective cumulative false positive and false negative error rates. The proposed framework will enable evaluation of other similarity metrics and the dynamic update of distributions when new data becomes available.

Using the improved processing parameters, the National Institute of Standards and Technology (NIST) will be able to continue entering new batches of firearm comparison results into each of the established populations to create continually growing "living distributions." These can be used to estimate cumulative false positive and false negative error rates for each subpopulation and will play an important role in assessing the strength of the evidence for a particular comparison. Results provide guidance for the collection of new data and enable further research into whether or not groups of firearms or class characteristics converge to the same statistical model and processing parameters. The data and framework can be applied to generate distributions for other tool mark identification metrics and guide their development. The conclusions drawn from this research serve as a stepping stone to answering important questions regarding subpopulations and the role they play in firearm identification error rates and data processing parameters. While not covered in this research, the protocol used can be applied to other tool mark regions of interest, such as firing pin and land impressions. There is also a potential for this research to be applied in other pattern evidence disciplines, such as fingerprint and shoe print identification.

Firearms, Tool Marks, Populations