A76 Statistical Pattern Comparisons of Striated Tool Marks: Defending Against Daubert and Frye Challenges

Nicholas D.K. Petraco, PhD, John Jay College of Criminal Justice, 899 10th Avenue, New York, NY 10019; Jacqueline Speir, MS, Rochester Institute of Technology, Digital Imaging and Remote Sensing Laboratory, 54 Lomb Memorial Drive, Rochester, NY 14623; Peter Shenkin, PhD, John Jay College of Criminal Justice, 899 10th Avenue, New York, NY 10019; Peter J. Diaczuk, BS, John Jay College of Criminal Justice, 445 West 59th Street, New York, NY 10019; and Peter A. Pizzola, PhD, New York Police Department Police Lab, 150-14 Jamaica Avenue, Jamaica, NY 11432-3725*

After attending this presentation, attendees will understand the application of computers and statistical pattern recognition techniques to areas of interest to practitioners of tool mark and firearms analysis.

This presentation will impact the forensic community by showing how practitioners can apply well documented statistical pattern recognition methods to striated tool mark evidence in order to make numerically based identifications and compute estimated error rates. Such abilities are necessary to defend the well known, but (largely) statistically untested conclusions in firearms and tool mark analysis. *Daubert* and *Frye* challenges to the admissibility of scientific trace evidence analysis are major issues for forensic science.

Given a set of tool marks with the same class characteristics, how likely is it, that when comparisons are made between the subclass and individual characteristics, a tool mark is misidentified? With recent challenges to the admissibility of tool mark evidence such a question is of paramount importance. In this presentation, it will be shown how methods of statistical pattern recognition (i.e., machine learning) can significantly aid in answering this question. Also, because these methods have been published and they allow for the computation of error rates, they can satisfy both the *Frye* and *Daubert* standards for admissibility of scientific evidence.

In this study, modeling clay is used to generate reproducible sets of striation patterns made with several standard tip screw drivers for slotted screws. The striation patterns are photographed under the stereo microscope and various measurements are made with the digital image processing software. Using these measurements, the striation patterns can be encoded into a feature vector. In combination with various Hilbert space kernels, we process the resulting feature vectors with principal component analysis (PCA), Fisher linear discriminant analysis (FLDA), maximum likelihood Gaussian classifiers (MLGC), support vector machines (SVM) and neural networks (NN). The advantages and drawbacks to each of the above statistical methods in the context of forensic tool mark analysis will be presented. Error rates, classification confidence intervals and credibility measures are estimated from the hold-out method and conformal prediction theory. Finally, how all the statistical methods presented in this talk can easily be extended to any set of tool marks made by virtually any tool will be discussed.

Tool Marks, Statistics, *Daubert* and *Frye*

 ** Presenting Author*