A139 Error Rates for the Identification of 9mm Firearms Using the IBIS

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After attending this presentation, attendees will have a firm understanding of statistical methods as they relate to the analysis of firearms impression evidence. The generation of Receiver Operating Characteristics (ROC) curves will aid in the analysis of best-known nonmatches for 9mm firearms. The ROC curves will allow for a visual representation of false positive and false negative rates.

The presentation will impact the forensic science community by addressing current concerns of firearms examiners relating to data interpretation. The results will address the National Academy of Sciences (NAS) Report regarding the scientific basis of firearms examinations. The main benefits will be the development of a system based upon instrumentation and data which are commonly available in forensic laboratories.

According to the National Institute of Justice (NIJ), the degree of correspondence which must be exceeded in order to reach sufficient agreement to effect an identification is the Best Known Non-Match (BKNM) as determined by each individual examiner and as produced by different tools.[1] The individual examiner gains this experience during an initial training period rather than at the beginning of casework examinations. Anecdotally, it is known that examiners do find better BKNMs during casework. In order to understand this process, this concept will be elaborated upon.[2]

The Integrated Ballistic Identification System (IBIS) developed by Forensic Technology International serves as the backbone of the National Integrated Ballistic Information Network (NIBIN) system.[3] This system allows for the data-basing of images of cartridge cases and bullets. For each cartridge case, two areas are imaged: the firing pin impression and the breech face impression. The proposed investigation involved the acquisition of 16 9mm center-fire handguns. All of the cartridge cases were entered into the 2D IBIS system in order to generate the match data. The acquisition method followed was established in a previous study.[4] The data was mined to evaluate the variance within/between relationships such as model, makes, firing conditions, etc.

One issue encountered in firearms is the determination of the number of Consecutively Matching Striations (CMS) method as described by Biassoti in 1959.[5] There has been much debate between the so-called *pattern matchers* and *line counters*. According to Nichols, one of the pitfalls of the CMS method is the large degree of false exclusions.[4] The discriminating ability of a method can be described by its sensitivity and specificity. The sensitivity of a method is its ability to detect a condition when the condition is present (or calling a *match*, a *match*). Specificity is the ability of a method to detect an absence when the condition is not present (or calling a *non-match* a *non-match*). One can also define methods according to their false positive rate (*fpr*) and their false negative rate (*fnr*). The concept of a BKNM can be defined in terms of the *fpr*; as the *fpr* tends to zero, the *fnr* tends to one. Thus, irrespective of a CMS or pattern matching approach, the concept of false exclusions is unavoidable. Conversely, if one reduces the number of false exclusions, the *fpr* rate will increase.

The ROC curves can be used to determine the crossovers between match and non-match. The ROC curve demonstrates the discriminating power of the method. In other words, it determines how well the method can differentiate between different states of the samples to which the method has been applied. This discriminating ability is directly related to the area under the ROC curve. The error associated with this method is determined by the parameter under evaluation. The *fpr* and the *fnr* are given as a function of the correlation scores which were obtained by the IBIS. The crossover from black to gray to white zones are indicated when the error rates are zero. The gray is where the match and non-match scores overlap. It is in this gray zone where the quality-quantity relationship is the most critical. The firearms examiner must apply skills, knowledge, and experience to evaluate striations to be able to ensure a valid conclusion. The ROC curve will also provide a measure of method discrimination irrespective of the method which the examiner provided. The data generated will be transformed to develop likelihood ratios for the interpretation of firearms evidence.

References:

[1]http://www.nij.gov/training/firearms-training/module11/fir_m11_t04_05.htm accessed on 2011-11-09

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3. Scicchitano, K.M., The effect of examiner variation in cartridge case acquisition on IBIS® correlation scores and the ability of the system to return a true positive, MS thesis, West Virginia University, 2011.
4. Biasotti, A.A. A statistical study of the individual characteristics of fired bullets. Journal of Forensic Sciences 4(1), 1959, 34–50.

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