A161 An Example Validation Procedure With Measures of Statistical Significance for Fingerprint Screeing Programs

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After attending this presentation, attendees will be able to apply this validation model to their own fingerprint search software to determine the accuracy of its search performance and evaluate the statistical significance of the results.

This presentation will impact the forensic science community by presenting a model validation scheme for automated fingerprint screening and statistical evaluation of search results.

The 1993 Supreme Court decision, *Daubert vs. Merrell Dow Pharmaceuticals, Inc.* established quality control and scientific performance standards for the admission of evidence presented at court. After reviewing forensic science disciplines, The National Academy of Sciences in their 2009 Report, *Strengthening Forensic Science in the United States: A Path Forward*, concluded that forensic science disciplines needed a stronger scientific foundation. Both stated that error rate estimates and data reproducibility were needed to assess the strength of scientific findings. This was particularly true in pattern recognition disciplines such as fingerprint examination.

The learning objectives of this study are to present a model approach to verify that AFIS software is working as designed and present a statistical foundation of search performance.

The first step was testing the accuracy and reproducibility of the AFIS system by searching the database of known fingerprints with a duplicate print. This is a self-matches-self experiment with a match on every attempt. Experimentally, standard ten-print cards were scanned at 600 dpi into no-loss Tiff files, the subject print was cropped from the ten-

print card, the minutiae were extracted by the AFIS system, and the print was enrolled into the database of known prints. The same process was used for the latent print starting with the same cropped fingerprint. The expected result of 100% search accuracy was obtained and repeated searches established 100% reproducibility.

Note that this model starts with exactly the same print and only validates that the AFIS software is working to its designed specifications. Real world fingerprints are entered from scanners or ten-print cards, and are not exact duplicates of known prints in the AFIS database. To emulate real world prints, latent prints were cropped from ten-print cards for each replicate trial and searched against its duplicate in the AFIS database with the expected results of 100% accuracy and 100% reproducibility. Actual results were less than 100% and were similar to earlier findings that suggested the AFIS minutiae extraction engine was not consistent; however, the validation model presented above disproved that theory. Additionally, because the latent and database prints were exactly the same, with the same orientation, quality and distortion, the ridge detail is not at fault.

Instead, it is the outer boundaries where the print was cropped that cause a slight shift in position of the print when the minutiae are extracted. A common digital imaging approach is lay a grid over the print and each box in the grid is evaluated for the presence of a minutiae point. When the overlay is positioned by the image's outer boundaries, slightly different boundaries shift the grid causing different minutiae to be recognized. Therefore, repeated croppings of identical prints do not produce identical minutiae patterns. This more closely emulates the real world where the outer boundaries of latent prints are not precisely controlled when they are entered into an AFIS system. In this case, population distribution statistics were used to describe how variations in the number of minutiae affect search accuracy. Similar experiments were conducted using different images of the same finger in a database of thirty ten-print cards and in a second database of six hundred individual prints.

This model of using known prints with predictable outcomes can be used for whole prints, or parts of whole prints, to verify the accuracy and reproducibility of any AFIS system. This study can help fingerprint examiners validate their own AFIS software, explain sources of error, and evaluate efficiency of new software by measuring the ratio of true candidate to false candidate prints. **Fingerprint, Validation, Statistical Significance**

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