B95 Statistical Tools for Forensic Analysis of Toolmarks

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The goal of this presentation is to provide statistical methods that will provide a means to objectively calculate a "degree of association" between matches of similarly produced toolmarks in order to validate the proposition that particular manufacturing methods produce marks on the workproduct (or tool) that are substantially different from tool to tool.

The statistical methods developed here may be applied to test the assumption that no two tools are manufactured with the same surface machining marks.

This presentation will show the results of a comprehensive statistical study of toolmark variation produced by several manufacturing methods (filing, grinding, whetstoning, broaching, stamping, and milling) and present a data reduction/statistical method software tool for comparison of the toolmarks.

There have been several studies that have shown the impact of various tool manufacturing methods on the individuality of toolmarks and striations produced on tools. These studies are reviewed in an article by Nichols[1] and have routinely shown that similar and/or sequentially produced tools have toolmarks that are distinctly distinguishable. The major shortcomings of these studies is that they concentrated on only a single manufacturing method (e.g., broaching) and they typically used a small number (less than 10) of samples. This work extends these previous studies by conducting a more comprehensive statistical study of toolmark variation produced by the different manufacturing methods by expanding the number of samples compared and generating a digital database to facilitate toolmark comparison and analysis.

Algorithms have been developed to facilitate the image matching and are intended to mimic the process employed by an examiner (i.e., rotate the samples on a comparison microscope so that principal features in each are oriented and adjust the "hairline" separating the split image in an attempt to find a strip along which the images exhibit similar patterns). The algorithms focus on several key steps: i) analysis of each image to determine directions of maximum and minimum variation at a given point; ii) comparison of one-dimensional image "strips" along the directions of greatest spatial variation; iii) iterative strategy for selecting local areas in each image for comparison, and; iv) match validation, i.e. determining whether an apparent match is real or an artifact due to similarities only in sub-areas of the images.

Results of the algorithms applied to image data sets (of no less than 100 images per manufacturing process) will be presented and discussed. Toolmark variations in manufacturing methods will be examined on commercial tools and on in-house sequentially produced samples.

1). Nichols, R.G., "Firearm and Toolmark Identification Criteria: A Review of the Literature," *Journal of Forensic Sciences* 42, 466-474 (1997).

Toolmarks, Statistics, Digital Imaging

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