D47 The Probabilities Associated With the Matching of Impression Evidence

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The goal of this presentation is to provide a method to evaluate the statistical probability associated with an impression evidence match.

This presentation will impact the forensic science community by demonstrating a new approach to impression evidence matching.

The unique correspondence between two impression marks is something one hears about all the time but the reasoning behind this assertion is conspicuously absent in the literature and would seem to be problem that is worth paying some attention to. Although the matching of impression evidence modified by irregular wear patterns or defects is certainly indicative of a unique history in the broad sense it doesn't automatically follow that what remains as evidence can be treated in the same way. The elimination of general features or class characteristics as a justification for unique correspondence is certainly a good first step and certainly the greater the number of matching features the more unlikely is the correspondence is due to chance however one is on dangerous ground if it is simply left as that. A good example of random marks is scratches and these can be overlaid onto a suspect pattern to reveal a match. The probabilities for this kind of pattern matching can be calculated based upon the detail that most people can resolve and so limits the possibilities of coincidence. This is equivalent to partitioning the scratches into component lines about 0.5 mm wide, which is the separation at which most people can distinguish line pairs and so when one is evaluating an array of scratches across a width *w,* either by eye or through a microscope*,* then the probability that we will find a particular line at a specific location in the array is . For an array in a half inch wide space for example the chances of finding a line at a particular place is meaning that in this case where there are 25 discernable line positions (*w/r*) on the pattern and any particular line that happens to be involved in a match to any other will be found in one of these locations.

The number of different ways that a sequence of *n* lines can be distributed over the *w/r* locations is given by

$$\omega_n = \frac{\left(\frac{w}{r}\right)!}{n!\left(\frac{w}{r} - n\right)!}$$

since the number of ways that N objects can be arranged in j subsets is

$$\omega = \frac{N!}{n_1!\,n_2!\,n_3!\ldots n_j!}$$

where and for the case of 15 matching lines out of a pattern of 20, for example, when there are 25 discernable line positions that is to say there are over three million different ways to construct sets of 15 lines and the probability of finding any specific one of them is one in 3.3 million which seems pretty convincing. That is of course until one realizes that there are actually going to be 15,504 patterns of 15 lines on the subject evidence which reduces this probability to 1 in 210. The presence of 15 lines amongst 25 is another matter however if they happen to form an uninterrupted sequence because the probability for this occurrence is

$$P_c = \left(\frac{n!\left(\frac{w}{r} - n\right)!}{\left(\frac{w}{r}\right)!}\right)^2 \left(\frac{\left(\frac{w}{r}\right)!}{n!\left(\frac{w}{r} - n\right)!} - \frac{N_1!}{n!\,(N_1 - n)!} + (N_1 - n + 1)\right)(N_2 - n + 1)$$

or 1 in half a million which is certainly less likely but still hardly unique. Had the pattern of scratches been spread over a 1 inch span rather than half an inch however the patterns would have been unique.

Probability, Evidence, Toolmarks

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