E57 A Reference Collection of Footwear Randomly Acquired Characteristics (RACs) for Frequency and Spatial Distribution Analysis

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Learning Overview: After attending this presentation, attendees will understand how RACs can be used to determine frequency and spatial distributions for probability assessments in forensic footwear analysis.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by providing a dataset to be used for statistical analyses and determining RAC probability assessments.

Footwear impressions are often deposited on a surface when a shoe worn by an individual makes contact with a surface. If detected and recovered, this evidentiary item can provide valuable investigative linkage to a suspect. RACs are frequently used to make comparisons between a questioned impression and known footwear. Recently, there have been courtroom challenges regarding the discrimination potential of footwear evidence, particularly when there are mass productions of similarly modeled and sized shoes. To address these challenges, the Federal Bureau of Investigation (FBI) is currently compiling data on the frequency and spatial distribution of RACs detected on the outsoles, then marked using Adobe® Photoshop® for more than 1,500 boots with a similar outsole pattern and class characteristics. A visualization of common and rare RAC locations and frequencies are represented in heat maps, providing a visual approach into the role RACs play in the differentiation of impressions and outsoles.

The purpose of this study was to assign and characterize, in a quantitative fashion, the frequency and positional descriptions of RACs on boot outsoles acquired by FBI agents in training as they performed similar tasks while wearing the same type of Eastern Mountain Sports® Day Hiker boots.

To prepare boots for analysis, the outsoles were initially cleaned and scanned. Test impressions of the outsoles were created with the use of black powder and adhesive sheets. The scanned boot impression and corresponding test impression were then aligned with each other. After background subtraction, a comparable boot shape was obtained.

Preliminary visual interrogations using only oblique lighting of each physical boot outsole were conducted after test impressions were created. Documentation of any discernible RACs were recorded on a paper template without magnification. Observations of the outsoles of the boots were made in conjunction with the corresponding scanned test impressions to assess that all of the lugs were impressed properly. When the impression was verified, Quality Assurance/Quality Control (QA/QC) checks for both intra- and inter-evaluator RAC assessments were completed.

Throughout the project, questions were raised about RAC frequency and placement. While there was no correlation between RAC counts and boot size, greater percentages of RACs were found in the toe and on the edges than in other areas of the boot. Results also indicate there is no correlation between RAC frequency and gender. Since weight, height, and gait were all unknown variables, they were not considered.

The FBI boot outsole reference collection dataset consists of more than 150,000 RACs and provides valuable information for quantifying the discrimination potential of footwear evidence, specifically in regard to the use of RAC location in outsole identifications. Shape similarity metrics will be applied in Phase II of this project to quantitatively compare the closeness of features across known non-match boots to evaluate the probability of two different boots sharing the same shaped feature or feature set.

Footwear Analysis, Randomly Acquired Characteristics, Database