E36 Comparing 6,000 Consecutively Fired .40 Smith & Wesson® Bullets and Cartridge Cases From a Sig Sauer® P320 Pistol Utilizing 3D Imaging and Objective Comparative Analysis

Jennifer L. Stephenson, MSFS, Federal Bureau of Investigation, Laboratory Division, 2501 Investigation Parkway, Quantico, VA 22135; and Erich D. Smith, MS*, 2501 Investigation Parkway, Rm 4340, Quantico, VA 22135*

After attending this presentation, attendees will be aware of the acquisition techniques used by two types of 3D instruments, the correlation procedures used to interpret the data collected from test-fired bullets and cartridge cases, the application of the results as it relates to firearms identification, variations occurring throughout the sequence, and interpretation of the variations.

This presentation will impact the forensic science community by establishing/developing an objective means to evaluate an identification and serve as a confirmation to the firearms/tool marks theory of identification that the extent of sufficient agreement of individual characteristics occurring in tool marks produced by the same tool exceeds that agreement which occurs in tool marks produced by different tools. The presentation will also inform the forensic community of applications of emerging technologies within comparative-based disciplines.

This study was conducted to determine the variation of individual characteristics on test-fired bullets and cartridge cases over the lifetime of a Sig Sauer® P320 .40 Smith & Wesson® semiautomatic pistol. The pistol was purchased new and had only been fired by the manufacturer for a standard function test prior to this study. The ammunition selected for this study contained brass-jacketed bullets and nickel cartridge cases with nickel primers.

A total of 6,000 cartridges were consecutively fired for this study over a period of two weeks. Of the 6,000 cartridges, 342 were collected for analysis. Cartridge sets of 1-10, 91-100, 491-500, and 991-1,000 were collected and inter-compared for each 1,000-cartridge interval. In addition to the multiple test fire sets, every 50th cartridge was collected. Cartridges that were collected for analysis were fired into a ballistic water tank. Prior to test firing, a screw was inserted into the hollow-point cavity to prevent bullet expansion upon entry into the water tank. Cartridges that were not collected for analysis were fired in an indoor firearms range, then the bullets and cartridge cases were disposed of. No parts of the pistol were cleaned until after cartridge 6,000 was fired.

The first test fire was used as the reference sample for comparative analysis against all of the subsequent test fires. Prior to the 3D image acquisition, the bullets and cartridge cases were laser etched with a unique identifier and cleaned with acetone. The instruments were subjected to daily performance checks. Images of land impressions on the bullets were acquired using confocal microscopy and analyzed with the application of a cross-correlation function. Images of breech face marks on the cartridge cases were acquired using photometric stereo and analyzed with the application of a bidirectional reflectance distribution function. Both the cross-correlation and bidirectional reflectance distribution functions provided objective numerical values representing the similarity between two samples topography. The numerical values were used to determine if there was a significant variation of individual characteristics over the sequence of test fires and whether or not the variations would prevent a result of identification from being rendered. The bullets and cartridge cases were also examined by several firearms/tool marks examiners to determine if they were still identifiable by traditional means. Photographs of the pistol's barrel and breech face were taken prior to firing and at every 1,000-round interval. These photographs serve as an additional indication of variation of individual characteristics over the sequence of test fires due to wear. The photographs also indicated the extent of buildup of brass, lead, and other residues over the lifetime of the pistol without cleaning.

Reproducibility of Marks, Confocal Microscopy, Photometric Stereo