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J10 The Determination of Heterogeneous and Homogeneous Line Intersections: Infrared (IR) Versus Polarized Luminescent Techniques

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After attending this presentation, attendees will better understand IR versus polarization techniques on heterogeneous and homogeneous line intersections. The two techniques employ two hand-held devices capable of connecting to a laptop, thus having practical implications in the field. The polarization can provide digital JPEG images for a direct observation of the area of line crossing for a sequential determination. Finally, the device allows ten modes of quantifiable geometrical measurements for an *in situ* comparison, which fulfills the quantifiable requirements recommended by the National Research Council Report in 2009.

This presentation will impact the forensic science community by implementing a novel method of the polarization technique on line intersection determination.

It is hypothesized that the determination of a line intersection is one of the technical challenges in providing evidence where a document is altered. A fraud case where the defendant altered the monetary value was the inspiration of this experimental study. The results of the study may answer the National Research Council's challenge to questioned document examination as being "less scientific" due to a lack of quantifiable measurements.

While a heterogeneous line intersection refers to a line crossing produced by two different writing ink materials (i.e., ballpoint pen vs gel ink pen of the same color), a homogenous line intersection is a line crossing made by the same writing ink material of the same color. It is more difficult to determine the sequence of line intersection in the latter. This study conducts a comparison in the evolution of two methods: IR and polarization. First, infrared luminescence, the main method used to perform such tasks at an affordable cost, indicates certain disadvantages. The IR examination (980 nm) compares a line crossing based on different color indications (quality) and ink concentrations. However, IR technique does not show any color display (reflected image) for ballpoint pen ink – the most common writing medium in the fraud case. Second, when applied to the homogenous line crossing, the color contrast produces an undesirable standard with vague contrast, making a sequential determination much more difficult and uncertain. Finally, current IR technique cannot provide any real-time, quantifiable measurements of stroke width, angle between two strokes, and any ink minutia (skipping, gaps, or holes). On the other hand, the polarization technique (based on the ability of waves to oscillate in more than one direction) enables reduced glare and improved background contrast. Further, the polarization method simultaneously addresses all three of IR's limitations, thus providing a better identification based upon a scientific and objective verification, not just upon a subjective decision of color differentiation and ink minutia.

The sample collection was a simulation of a real fraud case involving an altered number (making \$10,000 into \$40,000) under a purposive sampling method. The study selected four common types of pens of black color: ballpoint, gel ink, fountain, and permanent marker. A comparison was conducted between the heterogeneous and homogeneous line intersections against each other. The preliminary results indicate some practical differences and three advantages for polarization over IR. First, the polarization technique is a non-destructive method used either before or after the standard examination or verification (as a second opinion). Second, polarization can provide a quantitative measurement of the line intersection and/or other ink minutia in ten geometrical formats, making the examination more reliable and valid. Third, the application of polarization can produce a rapid examination at the

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scene, in the lab, and even in the courtroom. The results add much needed support for crime scene technicians, examiners, and/or investigators and render this method as sufficient and practical for a real time examination at scenes. The sequence of intersecting lines plays an important role in the forensic examination of a document. It is concluded that if our field conducts widespread testing and adoption of polarization techniques as common practice, our duties and performance on line intersections will be advanced from the past towards a more scientifically sound future.

Questioned Document Exam, Heterogeneous/Homogeneous Line, Polarization Technique