J12 Factors Affecting Electrostatic Detection Apparatus — 2 (ESDA2) Indented Writing Visualization

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After attending this presentation, attendees will gain a better understanding of factors affecting the ESDA2 visualization of indented writing, including paper type, the writing utensil used on the original document, relative humidity of the sample, and the ESDA2 toner development method.

This presentation will impact the forensic science community by providing a comprehensive guide containing the optimum conditions for recovering indentations on different paper types using the ESDA2. Document examiners will no longer waste time and resources nor will they potentially lose valuable evidence attempting to obtain the best conditions for visualizing indented documents through trial and error.

The ESDA2 develops indented impressions which are created when pressure is applied to the original document. Indentations on papers below the original are due to paper fibers breaking. This "invisible" writing provides valuable information about a case, missing person, etc., and even generates handwriting samples.

Past research has yielded poor results for coated paper, but the potential factors responsible for its poor performance have not been systematically examined.[1] Recycled paper is now commonly used but has not been investigated in previous studies. The goals of this study are to maximize the visibility of indentations with ESDA2 on bond, recycled ruled, glossy, and recycled bond paper controlling for three relative humidity levels (50%, 60%, and 70%) and to test three ESDA2 development techniques: Aerosol, Cascade, and Toner Application Device (TAD).

The relative humidity of indented documents prior to ESDA2 development has been examined in various studies.[2-6] James' and Noblett's research determined that the best quality indentations were observed when documents were humidified between 40%-60%.3 Baier stated, the more coated the paper, the more time it takes to humidify the paper to obtain a clear visualization of the indented writing with the ESDA2.2 Indented documents' relative humidity in the ESDA2 development is important. This research will determine the best humidity level for different paper types.

The development method is an additional factor to consider when examining ESDA2-developed indented documents. Research has been conducted on the Aerosol and Cascade Methods.[3,4] Baier concluded, Aerosol works best on the top sheet (sheet directly below original document) and when the indentation is clear, in contrast, Cascade was more efficient than Aerosol at developing weaker indentations.[2] James and Noblett determined Aerosol produced a higher quality score than Cascade, independent of paper type or amount of pressure applied.[3] Past research on ESDA2 toner-development methods have produced conflicting results. No research has been performed on the efficiency of the TAD technique in developing indented documents. This research will determine which ESDA2 development method produces the clearest visualization of indentations on different paper types.

A total of 1,080 indented documents were prepared using three writing utensils (ballpoint pen, gel pen, and mechanical pencil) on four paper types (bond, recycled ruled, recycled bond, and glossy). The samples were divided into subsamples of 30 and each subsample was subjected to different humidity levels (50%, 60%, or 70%). Each document was placed within the ESDA2 capacitor and charged. One toner development method (Cascade, Aerosol, or TAD) was applied per document (360 samples for each toner development method). A quality score from zero (no words visible) to four (all words and small details visible) was recorded. The Kruskal-Wallis test followed by Wilcoxon Signed-Rank Test with a Bonferroni Correction was applied to the data. The samples composed with the ballpoint pen had the highest quality score (p = 1.12 x 10-6). It is recommended that ESDA2 control indentations are composed with ballpoint pens for the original sheet. The optimum conditions for the paper types were: (1) bond paper (70% and Aerosol ($p < 4.00 \times 10^{-8}$)); (2) recycled ruled (60% and Aerosol ($p < 1.32 \times 10^{-3}$)); (3) recycled bond (60% and Aerosol ($p < 5.60 \times 10^{-3}$)); and, (4) glossy (60% and Aerosol ($p < 6.30 \times 10^{-5}$)). Based on this study, ESDA2 visualized indentations will be the clearest when recycled ruled, recycled bond, and glossy paper are humidified at 60%, while bond should be humidified at 70%; the Aerosol development method should then be applied across all paper types.

References:

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ESDA2, Indented Writing, Questioned Documents