

Development of a Supplemental Technique to Increase Visualization of Handwriting Indentations in Crumpled Documents with the Use of an Electrostatic Detection Device (EDD)

Kate Savoie, B.S.

Florida Department of Law Enforcement, Pensacola Regional Operations Center, 1301 N. Palafox Street, Pensacola, FL 32501

Forensic document examiners (FDEs) receive questioned documents in all sorts of conditions: chemically processed, folded, crumpled, wet, frozen, charred, wadded, or a combination thereof. Application of an Electrostatic Detection Device (EDD) is one of the key examinations performed on original questioned documents. These examinations have elicited superb information in the form of latent handwriting indentations as well as pattern impressions that may indicate a printing process, which otherwise might have remained unseen. Crumpled or wadded documents have proven a problem in the area of EDD examinations as the toner particles may adhere to the uneven and prominent creases and folds as opposed to the more subtle and delicate latent handwriting indentations or printing process impressions. This research attempts to develop a supplemental EDD technique in which increased relative humidity (RH), pressure by use of a weight, and/or a stretching technique may be applied to a crumpled piece of paper containing latent handwriting indentations after a traditional EDD exam has already been applied that did not yield fruitful results. These secondary techniques have proven in this research to allow for increased visualization of latent handwriting indentations.

Introduction

The intention of the research is to provide a secondary method to complete EDD examination on crumpled papers that would be an addendum to an examiner's or agency's current standard protocols for EDD examination. Currently, a document that is crumpled, folded, or wadded may be subjected to the same EDD procedure in place for non-crumpled paper. However, in cases of damaged documents, the results are typically of little value as the toner often will adhere to the crumples or folds that are interrupting the electrostatic nature of the paper to a greater degree than the handwriting indentations. The goal of this on-going research is not

to replace the current "normal procedure" used presently by any FDEs or agency, but simply to provide some additional routes to obtain handwriting indentations.

Materials

Indented Writing Samples:

The indented writing samples were produced on a Staples Signa 8½ x 11¾ inches, 15 pound, white, perforated writing pad with narrow-ruled sheets using an Aveo Metal Ball Point pen with medium point blue ink. (Note: Once sheets were removed from writing pad, each sheet measured approximately 8 ½ x 11 inches.)

EDD Examination:

A Foster and Freeman ESDA 2 with Document Humidifier and RS Hygrometer were used in conjunction with cascade development beads and toner to complete indentation examinations.

Digital Camera:

Images were captured using a Nikon D90 SLR Digital Camera with Nikon AF-S Micro and Nikkor 60mm Macro Lenses.

Application of Increased Relative Humidity:

A Powers Scientific Humidified Incubator Model HIS52SD was used to treat the pages with increased humidity in conjunction with a Fisher Scientific Humidity Monitor to measure relative humidity applied.

Application of Relative Pressure:

Troemner-certified 5 pound and 20 pound weights and a ½ inch-thick plate glass weighing 3 pounds, 10 ounces were used to apply relative pressure.

Methodology

To produce indented writing on a piece of paper to be tested, two sheets of lined notebook paper were laid on top of each other and remained stationary as the top sheet was written on. The indented writing varied for each sheet and included the title of the experiment, the applicable experimental conditions for that particular piece of paper (for example "Relative Humidity: 80 %"), initials, and the date. This information was written on the top sheet using the Aveo pen. The bottom sheet was marked unobtrusively with the same information in a different area so as not to interfere with any of the indentations produced from the writing on the top sheet. The bottom sheet was then separated from the top sheet. All bottom sheets were wadded into a paper ball. After approximately 48 hours, the sheets were "un-balled." There were four categories of experimental factors used in this research: 1) High Humidity Only Applied; 2) Pressure Applied First; 3) High Humidity then Pressure Applied; and 4) Pressure Applied First and then High Humidity Applied. There were three levels of relative humidity applied (75%, 80%, and 85%) and three levels of relative pressure applied (3 pounds, 10 ounces; 8 pounds, 10 ounces; and 20 pounds). This allowed for 24 different parameters to be tested. One sheet was examined

following only the normal procedure of the laboratory for a total of 25 sheets. (Note: For the dates this research was completed, the average room temperature was 72°F and the Relative Humidity was 30%. The average temperature of the Document Humidifier was 74°F and the Relative Humidity was 61%.)

This laboratory's standard procedure for an EDD indentation examination was applied to all 25 crumpled sheets first to observe any handwriting indentations before application of different experimental factors. Images of the results of each indentation examination were captured with a digital camera for documentation. After this was complete, the experimental procedures were then applied to the appropriate pages. After applying the experimental procedures, some documents were randomly chosen throughout the experiment for application of a stretching technique. Stretching or attempting to flatten a document is not currently recommended by the EDD manufacturer. However, it is the belief of this examiner that stretching a crumpled document after it has been subjected to humidification may allow for increased visualization of possible handwriting indentations. The steps followed in each procedure are outlined below.

Normal Procedure:

1. Place document in Document Humidifier for approximately 3 minutes.
2. After three minutes, place document on EDD platen.
3. Turn EDD vacuum pump on.
4. Cover document and EDD platen with imaging film and cut to size.
5. Turn corona bar on and pass over document two to three times maintaining a distance of approximately 1-2 inches.
6. Raise the EDD platen at an angle and allow cascade development beads containing toner particles to pass over the film.
7. If positive for handwriting indentations, preserve image with plastic adhesive sheet. *Note: This step was substituted in this research project. Digital images captured the resulting effects of the EDD examination regardless if there were any discernible handwriting indentations.*

Secondary Procedure - High Humidity Only Applied:

1. Three sheets labeled accordingly were placed

separately at different intervals in a humidified incubator for approximately 3 minutes at three levels of relative humidity: 75%, 80%, and 85%.

2. After 3 minutes, each sheet was subjected to an EDD indentation examination using the cascade method.
3. Digital images captured the resulting effects.

Secondary Procedure - Pressure Applied First:

1. Three sheets labeled accordingly were placed separately under three different weights (3 pounds, 10 ounces; 8 pounds 10 ounces; and 20 pounds) for approximately 24 hours.
2. After 24 hours, each sheet was humidified at the relative humidity of the Document Humidifier (average 61% relative humidity) for approximately 3 minutes.
3. After 3 minutes, each sheet was subjected to an EDD indentation examination using the cascade method.
4. Digital images captured the resulting effects.

Secondary Procedure - High Humidity then Pressure Applied:

1. Nine sheets, labeled accordingly, were placed three at a time in the humidified incubator for approximately 3 minutes at 75%, 80%, or 85% relative humidity.
2. After 3 minutes at the relative humidity level, each sheet was then placed under a different weight (3 pounds, 10 ounces; 8 pounds, 10 ounces; or 20 pounds) for approximately 24 hours.
3. After 24 hours, each sheet was humidified in the Document Humidifier for approximately 3 minutes.
4. After 3 minutes, each sheet was subjected to an EDD indentation examination using the cascade method.
5. Digital images captured the resulting effects.

Secondary Procedure - Pressure Applied First then High Humidity:

1. Nine sheets, labeled accordingly, were placed three at a time under a different weight (3 pounds, 10 ounces; 8 pounds, 10 ounces; or 20 pounds) for approximately 24 hours.
2. After 24 hours, sheets from each weight category were placed in the humidified incubator for approximately 3 minutes at 75%, 80%, or 85% relative humidity.
3. After 3 minutes, each sheet was subjected to

an EDD indentation examination using the cascade method.

4. Digital images captured the resulting effects.

Tertiary Procedure - "Stretching Technique" (optional):

1. Sheet was humidified at the relative humidity of the Document Humidifier.
2. Sheet was removed from humidifier.
3. Edges of sheet were firmly gripped and then pulled slightly.
4. Process was repeated as needed on other edges of sheet.
5. Sheet was subjected to an EDD indentation examination.
6. Digital images captured the resulting effects.

Once all experimental procedures were complete, the images obtained were then examined to determine whether or not the visualization of handwriting indentations improved. A score was applied to both the "before" images and to the "after" images based on the following criteria:

EDD Indentations Score (0-4):

- 0 – No indented writing was observed.
- 1 – Illegible indented writing observed (could not distinguish letterforms, numerals, or symbols; i.e. lines).
- 2 – Some legible indented writing observed (could distinguish letterforms, numerals, and/or symbols, but not whole words).
- 3 – Legible indented writing observed (could distinguish or interpret whole words).
- 4 – Very legible indented writing observed (could distinguish or interpret most or all of the indented writing).

Results

A score of 0, 1, 2, 3, or 4 was given to the image taken of the indentations both after the normal procedure was applied and then after the experimental procedure was applied in order to determine if the experimental procedure had successfully allowed for visualization of more or less of the indented writing. See Table 1 for the results. In some cases, as noted in the table, the scores did not change though improvement was noted. This is referring to the increased visualization of the indentations in which the indentations were clearer or more easily discernible, but did not improve enough to increase the score.

	Normal EDD	Secondary EDD		Tertiary EDD	
<u>Procedure</u>	<u>Before Score (0-4)</u>	<u>After Score (0-4)</u>	<u>Improvement?</u>	<u>After Stretch Score (0-4)</u>	<u>Improvement after Stretch?</u>
Normal Procedure - 64%	2	2	Yes		
High Humidity - 75%	2	3	Yes		
High Humidity - 80%	0	1	Yes	1	Yes - very little
High Humidity - 85%	2	3	Yes		
Pressure Before - 3 lbs, 10 oz	1	1	Yes		
Pressure Before - 8 lbs, 10 oz	1	3	Yes		
Pressure Before - 20 lbs.	0	2	Yes		
75%, 3 lbs, 10 oz	2	2	Yes	3	Yes
75%, 8 lbs, 10 oz	1	1	Yes		
75%, 20 lbs	2	2	Yes		
80%, 3 lbs, 10 oz	2	3	Yes		
80%, 8 lbs, 10 oz	2	2	Yes		
80%, 20 lbs	1	2	Yes	3	Yes
85%, 3 lbs, 10 oz	1	1	Yes	2	Yes
85%, 8 lbs, 10 oz	2	2	Yes - some		
85%, 20 lbs	2	3	Yes	3	Yes
3 lbs, 10 oz, 75%	2	2	Yes		
3 lbs, 10 oz, 80%	2	3	Yes		
3 lbs, 10 oz, 85%	2	2	Yes		
8 lbs, 10 oz, 75%	2	2	Yes		
8 lbs, 10 oz, 80%	2	3	Yes		
8 lbs, 10 oz, 85%	1	2	Yes		
20 lbs, 75%	2	2	Yes		
20 lbs, 80%	0	2	Yes		
20 lbs, 85%	1	2	Yes	3	Yes

Table 1. Scoring of EDD results before and after experimental secondary and tertiary procedures.

Discussion

Visualization of indented writing scores either remained the same or improved in all experimental procedures (See Figures 1-2). However, it was difficult to show an inverse correlation between any of the crumpled papers and the specific experimental procedure utilized due to the fluctuation inherent in some of the experimental factors. Specifically, the “crumpling” varied with each sheet. Some sheets were more crumpled and some were less due to the lack of a standard method to crumple a document uniformly each time.

Another factor was the vacuum pressure the EDD exerted on the document. The vacuum pressure of the EDD platen used in this research was measured at 13 psi with a vacuum gauge. Foster and Freeman recommends a minimum limit of 11 psi and maximum limit of 15 psi of pressure. However, this vacuumed pressure, along with the transparent film placed over the document during the initial EDD run, applied its own “flattening” technique, or relative pressure, to the crumpled documents.

It was noted that indented writings did not de-

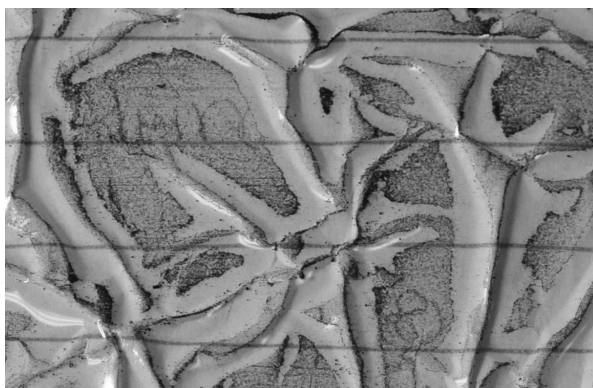


Figure 1. Image of EDD result with Normal EDD Procedure.

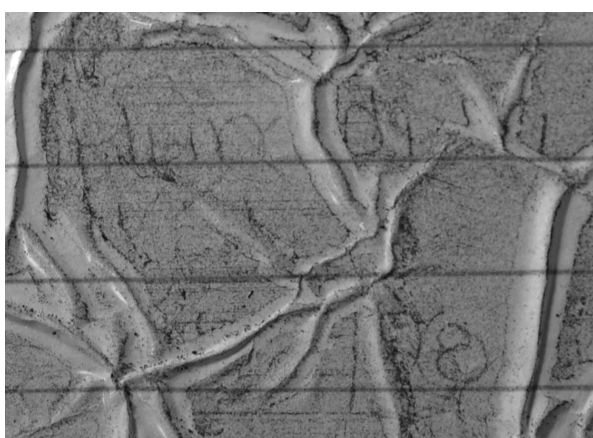


Figure 2. Image of Secondary EDD result after 75% RH Applied.

grade after two, and in some cases, three EDDs. Furthermore, the application of a slight stretch to the edges of the document allowed for observation of additional indented writing in the crumpled paper (See Figures 3-5).

Conclusion

In casework, examiners receive a myriad of crumpled, wadded or otherwise damaged documents. This research was undertaken to design and test supplemental EDD procedures that could produce better results than the normal procedures one's laboratory presently has in place. It is the belief of this examiner, that after an initial run of the EDD on a crumpled document, additional humidification, some stretching, and a second run of the document on the EDD may reveal additional indentations.

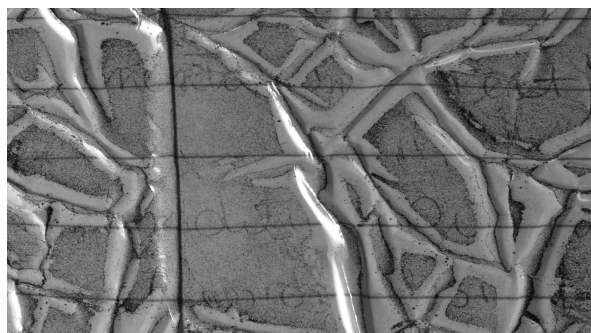


Figure 3. Image of EDD result with Normal EDD Procedure.



Figure 4. Image of Secondary EDD result after 80% RH and 20 lb. weight Applied.

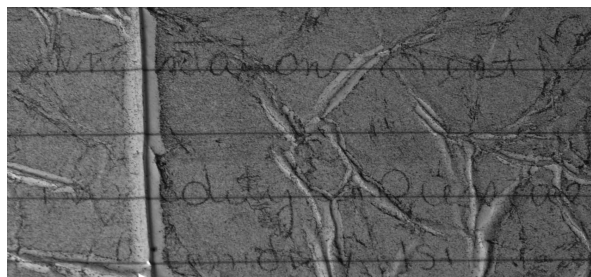


Figure 5. Image of Tertiary EDD result after Stretching Technique Applied.

References

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