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## W6 Frequency Occurrence in Handwriting and Hand Printing Characteristics

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After attending this presentation, attendees will have a significant understanding and appreciation of the statistical bases for handwriting comparisons and how to present such information in court.

This presentation will impact the forensic science community by providing information that can be used in court cases in which statistical foundation and probability become weight or admissibility issues.

Handwriting comparison has a rich history in both documented methodologies and admissibility in courts across the United States. During a literature search, numerous small and moderate studies were found that collectively provided significant, but not necessarily proper, foundation for questions of uniqueness and probability of handwriting and hand printing characteristics. In 2009, the National Research Council Report, *Strengthening Forensic Science in the United States: A Path Forward*, sought to make recommendations to strengthen forensic disciplines through strengthening the statistical foundations for each discipline. In response to that report, workshop presenters Vastrick and Schuetzner designed and instituted a four-year comprehensive study of frequency occurrence in handwriting and hand printing characteristics within the United States. Vastrick and Schuetzner were joined by Mark Johnson and Michele Boulanger, both statisticians with experience in forensic science and standards of methodologies. Johnson and Boulanger were tasked with being the driving force behind the project and developing the procedural methodologies using Vastrick and Schuetzner as subject matter experts. The purpose was to make this a statistics project about handwriting comparison as opposed to a handwriting project with statistics. The project was funded by the National Institute of Justice (NIJ).

Based on *Handwriting Identification: Facts and Fundamentals*, along with current population statistics, Johnson and Boulanger produced a stratified sampling frame that best represented population sampling.<sup>1</sup> In addition, factors potentially influencing handwriting such as age, handedness, and education were taken into consideration in developing the frame. One aspect of this workshop will be to understand the population sampling selection process and attendees will have opportunities for some hands-on experience with this subject. Within the final report are the eventual results of the population sampling and these results will be highlighted to workshop attendees. It is hoped that this information will provide the basis from which future sample collections are made for handwriting collection purposes. In addition, this project provided quantitative results to the lists of factors that affect handwriting and these results will be discussed.

Each phase of the project had to undergo pilot testing and attendees will receive experience in each of the processes. The most influential pilot test was the Attribute Agreement Analysis (AAA). The statistical aspects of the AAA approach are embodied in the International Organization for Standardization Technical Report (ISO TR) 14468. Workshop attendees will conduct an experimental AAA.

Attendees will receive detailed instruction into the process of selecting and testing handwriting characteristics for this project. Originally, there were more than 2,500 characteristics selected, but pilot testing reduced this number significantly to 786. Attendees will learn about the initial selection process and the testing processes that were used.

Attendees will receive background information into the data entry process and will have the opportunity to use a database in order to understand the methods used in this research.

Product rule analysis was conducted on sets of specimens resulting in 97.01% of all cursive and 98.96% of all hand-printed feature pairs having a correlation of plus or minus 0.2 for which the product rule is satisfactory. Attendees will have the opportunity to use both the hand printing and cursive data spreadsheets to manually test the independence or interdependence of several pairs of characteristics.

Confidence limits are the range in which population samplings can be statistically accepted as being within 95% confidence level. This range will be explained and the mathematical equation used to establish 95% confidence limits will be applied several times in planned exercises in order to provide experience and understanding of this factor to the workshop attendees. The mathematical equation is moderately complex, so several exercises to establish a level of comfort will be required.

Each attendee will be provided a mock query and given several test samples from which they will have the opportunity to enter the data and receive a canned report as to the frequency occurrence of each character entered, their corresponding 95% confidence limits, and the results of applying the product rule to their results.

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## Workshop - 2016

Each attendee will receive an electronic packet containing the final report of the research project, copies of historical papers concerning statistics in handwriting, copies of charts reflecting features that affect handwriting, publications concerning population statistics within the United States, a blank database, the final project spreadsheet of results, and a mock query. Also included will be several exercises as previously described.

Attendees will be cautioned about potential abuse and misuse of the project results and cautioned regarding the measures taken to limit the potential for abuse. Attendees will use the query in some of these ways to illustrate the potential for misuse.

The workshop will close with a roundtable discussion as to uses for this information and future enhancements to the project. Attendees will be encouraged to solicit other forensic document examiners to receive training in the use of the material from this workshop. Due to its overall complexity, it would not be desirable to self-train.

### Reference(s):

1. Huber R.A., Headrick A.M. *Handwriting Identification: Facts and Fundamentals*. Boca Raton, FL: CRC Press, c1999.
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### Statistics, Frequency Occurrence, Handwriting