

# Mason Research

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# Bringing Scientific Certainty to Handwriting Analysis



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**F**inding fingerprints at a crime scene and then using a database to match them to the correct person. Using a high-tech device to scan the iris of someone's eye to allow that person access to a high-security room. We've all seen it on television and in the movies, but few of us know that biometrics is the name of the science behind these techniques or the research that is being done in this field.

Biometrics, according to Merriam-Webster, is "the measurement and analysis of unique physical or behavioral characteristics especially as a means of verifying personal identity." The most common biometric identifiers are fingerprints, irises, and faces. But what about handwriting? Is handwriting individual enough to identify a person?

Mason researchers Don Gantz and John Miller believe it is. Together with three other Mason statistics professors, they are responsible for groundbreaking research and results pertaining to handwriting analysis.

For several years, Gantz, who codirects Mason's Document Forensics Laboratory with Miller, has been researching handwriting as a biometric identifier in collaboration with Mark Walch of the Gannon Technologies Group and with forensic scientists from the FBI. Together, Gantz and Walch created software based on the mathematical structure of letters that can match a handwriting sample to the correct person in a database with considerable accuracy.

The underlying premise of using handwriting as a biometric identifier is that each person incorporates individual features into his or her handwriting, which can be used to distinguish it from that of other writers. To evaluate this premise of individuality, the Document Forensics Laboratory compares handwriting using an automated system that provides quantitative data for verification of common features and can process a larger volume of samples than could be handled by manual examination.

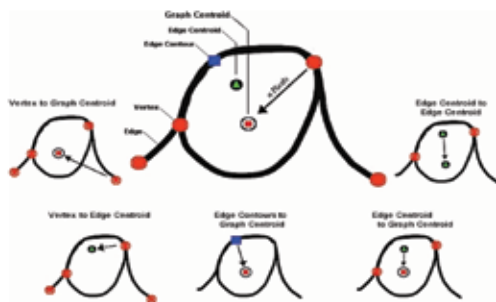
"Key to the success of our software is the statistical analysis that takes into account hundreds of physical measurements—relating to curvature gradation, directions, and size—of each letter or digit," says Gantz, who is also chair of the Department of Applied Information Technology in the Volgenau School of Information Technology and Engineering. "The software implements the statistical algorithms on samples of a person's writing to define a multi-dimensional mathematical profile that captures the writer's uniqueness. Such writer profiles are stored in a database that can be searched to determine possible writers of a questioned document."

Using this technique, referred to as handwriting-derived biometric identification, is a computationally intense process. It applies isomorphic graph matching, a technique based on graph theory that is used to identify the same written forms in different writing samples. It statistically compares measurements on similar objects across different writing to identify those characteristics that best distinguish or characterize individual writers, such as pen strokes, loops, and crossed lines, to come up with a mathematical characterization of a writer's uniqueness. The technique promises to play an important role in forensic document examination.

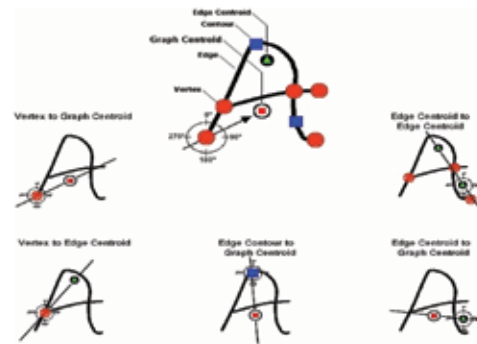
In practice, forensic document examiners have relied on their experience to tell them whether writing samples match. Handwriting evidence submitted in a court of law is often analyzed by an expert document examiner trained to notice similarities and differences between samples. A potential weakness in this presentation of evidence is its dependence on the subjective opinion of the document examiner. The software developed by the Document Forensics Laboratory effectively matches different samples of the same person's handwriting based on objective mathematical analyses, making it possible to present scientifically based handwriting evidence.

# Graph-based Features

## Distance Features

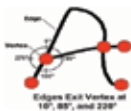


## Directional Features

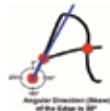


## Descriptor Features

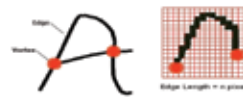
### Exit Direction



### Skew



### Edge Length



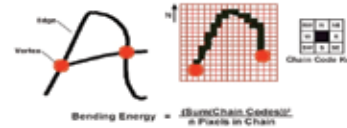
### Edge Aspect Ratio



### Bezier Offsets

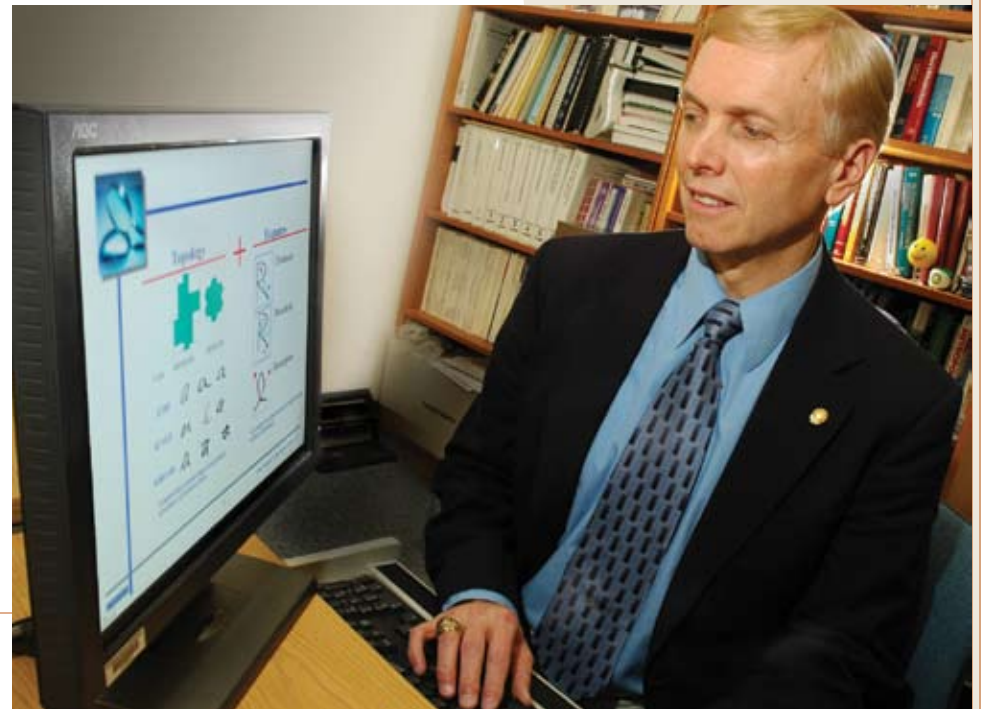


### Bending Energy



Left, this image shows how the letter forms are measured for analysis. Below left is a sample of the letter that was used to collect the 5,000 writing samples for biometric evaluation. Below right, Gantz demonstrates the software.

Our London business is good, but Vienna and Berlin are quiet. Mr. D. Lloyd has gone to Switzerland and I hope for good news. He will be there for a week at 1496 Zermatt St. and then goes to Turin and Rome and will join Col. Amy and arrive at Athens, Greece, Nov. 27<sup>th</sup> or Dec. 2<sup>nd</sup>. Letters there should be addressed 3580 King James Blvd. We expect Charles E. Fuller Tuesday. Dr. S. M. Luard and Robert Singer, Esq., left on the "J.K. Express" tonight. My daughter chastised me because I didn't choose a reception hall within walking distance from the church. I quelled my daughter's concerns and explained to her that it was just a five minute cab ride + it would only cost \$6.84 for this zone.

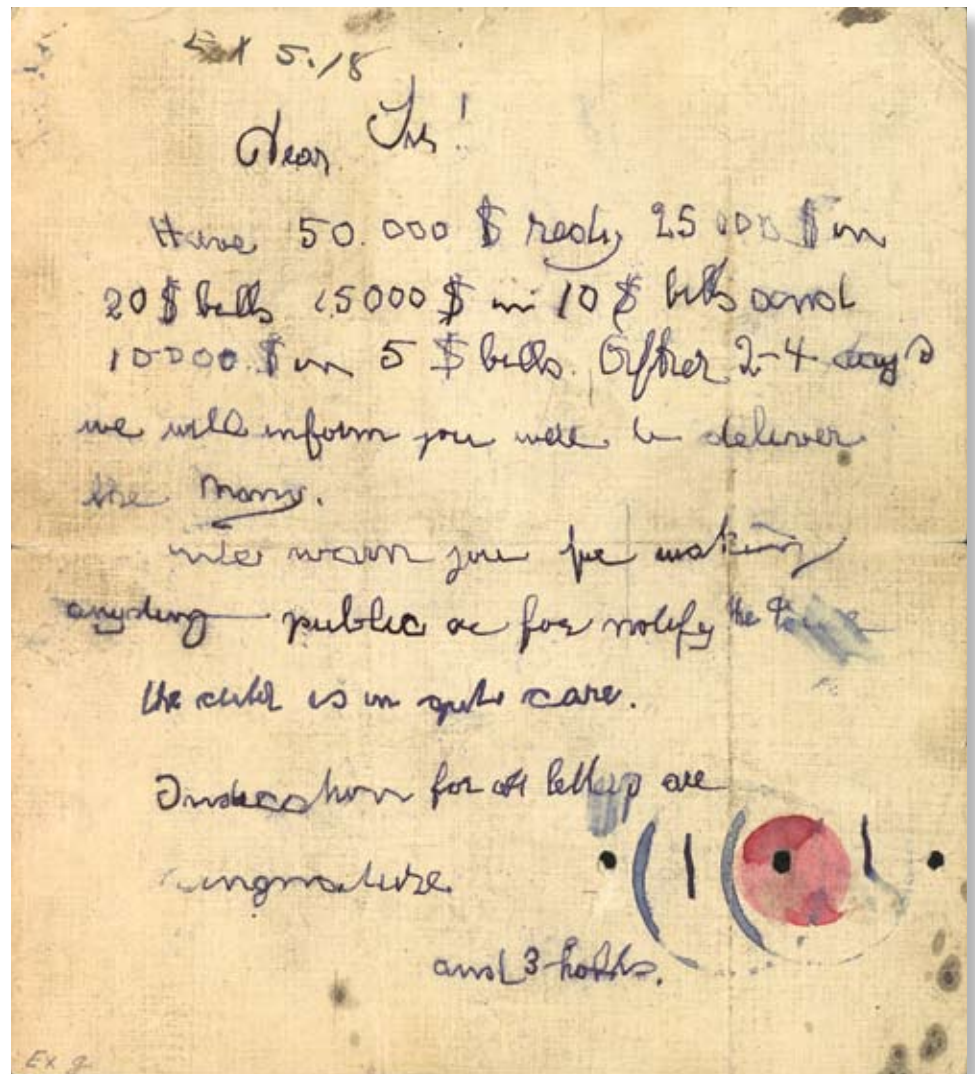


To further develop and test this theory, Mason researchers have collaborated with FBI forensics researchers. The FBI, which supports much of Gantz's work, provided the Document Forensics Laboratory with access to a database of more than 5,000 writing samples that were collected in a controlled setting from more than 500 individuals. Their new technique has been identified by the FBI as one with the potential to make forensic document examination scientifically reliable and accurate, resembling fingerprint and DNA analyses as a basis for evidence in a court of law.

The Document Forensics Laboratory has partnered with the Gannon Technologies Group to build a scientifically based foundation for handwriting identification. Over the past two years, Gantz, Walch, and Miller have presented their findings at major document exploitation conferences and symposia, including the 2006 annual meeting of the American Association for the Advancement of Science.

Says Walch of their progress, "We have been able to achieve results that just two years ago were not considered possible."

—Jennifer Freeman



The Lindbergh kidnaping was the first high-profile case for forensic document examiners in the United States. Gantz and his colleagues are applying their methods to the analysis of a number of documents involved in this case. The ransom letter is shown here.