Conventional Approaches to Fingerprint Comparison
“Assistant Commonwealth's Attorney Bethany Harrison said Lynchburg police matched prints on an orange juice bottle left at the scene of a breaking and entering to 33-year-old Bernard Wood.”
“Authorities say DNA evidence found on condoms inside the apartment and fingerprints identified the defendants as the culprits.”
Headline – Prosecutor: Ohio Teen Fatally Shot Twin Brother

“The trial of a man accused of fatally shooting his identical twin brother began Tuesday with prosecutors revealing new fingerprints linking the man to the killing while the defendant's lawyer insisted another man had masterminded the attack.”
“PC Bellinger added: "The fact that the victim retained the evidence, despite what had just happened, was crucial since Freeman Roach’s fingerprints on the items enabled us to place him at the crime scene."
“A leading US forensic expert has called for a radical review of fingerprint testing to determine the extent of flawed identification.”

"I would strongly recommend a review of all fingerprint identifications outside the confines of the agency first effecting the identification."

– James Starrs, professor of law and forensic sciences at George Washington University
"Now, UC Irvine criminologist Simon Cole has shown that not only do errors occur, but as many as a thousand incorrect fingerprint “matches” could be made each year in the U.S."
The Achilles' Heel of Fingerprints

“Our current approach to fingerprint evidence, in which experts claim 100 percent confidence in any match, is **dangerously flawed and risks causing miscarriages of justice.**”
National Academy of Sciences Report
“Strengthening Forensic Science in the United States: A Path Forward”

“Thus, not all fingerprint evidence is equally good, because the true value of the evidence is determined by the quality of the latent fingerprint image.”
National Academy of Sciences Report
“Strengthening Forensic Science in the United States: A Path Forward”

“With the exception of nuclear DNA analysis, however, no forensic method has been rigorously shown to have the capacity to consistently, and with a high degree of certainty, demonstrate a connection between evidence and a specific individual or source.”
Do these and other challenges have any substance?
Criteria

- Let’s consider the following:
  - Scientific validity
  - Sufficiency
  - Consistency
  - Transparency
  - Reproducibility
  - Training
Criteria

• Scientific validity
  – What is the scientific basis for fingerprint individualisation?

• Sufficiency
  – What constitutes a “usable” latent print?

• Consistency
  – How do we ensure that each examiner achieves the same result?
Criteria

• Transparency
  – How do we explain how those results are achieved?

• Reproducibility
  – How can we ensure that the same result is achieved for the same comparison?

• Training
  – How do we train examiners to competence?
Error Rate

How often do we expect the process to produce an incorrect / inaccurate answer?
Is This a Fair Set of Criteria?

- **Legal:** judges, juries, lawyers, investigators
  - Robust information to understand our process
- **Scientific:** forensic scientists
  - Set of tests
GTKPR

- General acceptance
- Tested
- Known standard
- Peer reviewed / publication
- Rate of error (known or potential)
 GTKPR

- **General acceptance**
  - What is meant by the scientific community?
    - Legal and scientific
      - More encompassing than just the fingerprint community?
• **Tested**
• **Peer reviewed**
  – Scientific validity, reproducibility, sufficiency
Daubert Tests

• In fact Daubert can help clarify what we mean by scientific validity

“To the contrary, under the Rules, the trial judge must ensure that any and all scientific testimony or evidence admitted is not only relevant, but reliable.”

“In a case involving scientific evidence, evidentiary reliability will be based upon scientific validity.”

“The inquiry is a flexible one, and its focus must be solely on principles and methodology, not on the conclusions that they generate.”

DAUBERT v. MERRELL DOW PHARMACEUTICALS, INC., 509 U.S. 579 (1993)
What Constitutes Reliability?

- Scientific validity
- Consistency
- Reproducibility
Our process needs to be reliable —
It is not all about the “expert”
National Academy of Sciences Report

“The simple reality is that the interpretation of forensic evidence is not always based on scientific studies to determine its validity.”

“In terms of scientific basis, the analytically based disciplines generally hold a notable edge over disciplines based on expert interpretation.”
GTKPR

- **Known standard**
  - By definition, standards introduce consistency
  - Using known standards brings training into consideration
• Rate of error
  – While significant, this will not be directly addressed
Where Are We?

• We have suggested a number of criteria by which to consider our process of fingerprint comparison
• All are logical and relevant
• We can reference some to legal commentary
• We can reference others to scientific reports, such as NAS
How Current Approaches Measure Up

- Scientific validity
- Sufficiency
- Consistency
- Transparency
- Reproducibility
- Training
Non-Numerical Approach

- We have a non-numerical method in the USA
  - For completeness, we’ll consider the numerical approach too
Terms and Definitions

- Minutiae: ridge endings and bifurcations only
  - Not dots
- Features: the totality of anatomical features
Non-Numerical Approach

- No set threshold of features required
- ACE-V method
  1. Analysis
  2. Comparison
  3. Evaluation
  4. Verification
Non-Numerical Approach
Non-Numerical Approach
Non-Numerical Approach

• How does this approach work?
  – Personal thresholds?
  – Institutional thresholds?
    • Norming
  – “Black Box”
Non-Numerical Approach

- Some aspects are not clear
  - Are all features of equal evidential weight?
  - If not, how do we apportion the weight?
  - Do we fully understand the reproducibility of all features?
Non-Numerical Approach

• How does the non-numerical approach measure up against our criteria?
Comparison Criteria and the Non-Numerical Approach

• Scientific validity
  – Early pioneers?
  – Biological “uniqueness”? 
  – Empirical evidence?
  – Probabilistic studies?
• Does this fully support an ability to conclusively match a latent print to a known where there are few features, distortion, etc.?
Comparison Criteria and the Non-Numerical Approach

• Sufficiency
  – Doesn’t offer any definition

• Consistency
  – What part of ACE-V ensures the same result?

• Transparency
  – We explain the A, the C and the V
  – The “E” in ACE-V explains how the examiner arrives at her/his evaluation
Comparison Criteria and the Non-Numerical Approach

- Reproducibility
  - What part of ACE-V makes it reproducible?
- Training
  - How do you train someone?
ACE-V

- What NAS had to say about ACE-V:

  “ACE-V provides a broadly stated framework for conducting friction ridge analyses. However, this framework is not specific enough to qualify as a validated method for this type of analysis.”

- ACE-V is an excellent description of how to carry out a fingerprint comparison
  - In fact any comparison...

Numerical Standards

• Define a strict threshold of features
  – Match or exceed and it is an “individualization”
• Can be referenced to early pioneers
• Also often using ACE-V
Numerical Standards

LATENT PRINT REF 001

LEFT MIDDLE FINGERPRINT SMITH

Conventional Approaches to Fingerprint Comparison
Numerical Standards

- Are thresholds valid?
- Ne’urim Symposium and IAI Standardisation Committees
  - No scientific basis
- Persuasive
  - “An illusion of certainty”
Numerical Standards

• Let’s see how this approach measures up...
Comparison Criteria and the Numerical Standard Approach

- Scientific validity
  - How is the threshold derived?
  - Is there a simple threshold?
- Sufficiency
  - Allows a definition, but is it sound?
- Consistency
  - IF all examiners apply consistent definitions
- Transparency
  - Provides an “illusion of certainty”
Comparison Criteria and the Numerical Standard Approach

- Reproducibility
  - As with consistency, if definitions are applied
- Training
  - Yes, but is it sound?
Comparison Criteria and the Numerical Standard Approach

- Interestingly, some numerical systems allow the threshold to be modified
- Also, some numericists insist that they do approach examinations holistically — using all features
- The non-numeric / numeric distinction may not be so well defined
Is There a Way to Improve Our Process?

• One way is to consider introducing probability concepts
  – Already used in other areas of forensic science
  – In fact, latent print comparison can already be considered to be probabilistic
• Perhaps we can research and develop “tools” to help us
Summary

- Our current approaches do not fully address the criteria we have set
- But neither do they invalidate the process completely
  - We all know that fingerprints, in general, provide robust intelligence / evidence
Summary

- Probability and the associated tools are, of course, unlikely to address all the challenges, but they can bring some significant benefits.
- In this workshop, using a first generation tool developed by the FSS, we are going to explore how probability and the associated tools can be used to highlight the benefits.
Questions?
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Note: All images are courtesy of Paul Chamberlain.