The Ancient Art of Firearm-Related Toolmark Identification

Righting Wrongful Convictions: Challenging Flawed Forensics
April 7, 2011
The goal of Firearm-Related Toolmark (FATM) analysis

To determine whether a particular firearm produced the markings on a bullet or cartridge case associated with a crime
How?

Generally:
- Markings on bullets and cartridge cases believed to be associated with a crime are compared against
- Markings on bullets and cartridge cases test fired from a firearm believed to be associated with a crime
- Do they match? Or, “sufficiently” match?
- Evidentiary “show up”
Tools
What markings are used for comparison?

Scratches ("striations" or "striae") and impressions left by the interior surface of the firearm.
Interior of a firearm

- Breach (face)
- Extractor
- Firing pin
- Ejector
- Magazine
- Chamber
- Barrel with rifling
Firearm examiners recognize three categories of markings:

- Class
- Individual
- Subclass
Class Characteristics

- Characteristics that are shared by bullets and cartridge cases fired from the same make and model of firearm
- E.g. Direction of rifling, number of lands and grooves, shape of firing pin impression
Individual Characteristics

- Characteristics that firearms examiners believe are unique to a firearm, resulting from some combination of irregularities in the machining process and imperfections that emerge during the subsequent use of a firearm.

- No definition of what makes a mark unique – subjective decision by the examiner.
Subclass characteristics were not recognized until 1989

Until 1989, there was a binary system. All marks were deemed either:

• **Class characteristics** shared by all firearms of a given make and model, or

• **Individual characteristics** unique to a single firearm.
Misidentifications ensued

- Misidentifications resulted even though so-called “individual” marks lined up

- *E.g.* 1915 murder case (*Stielow*)
  - Tests one revolver from defendant’s home
  - Nine “matching” striae
  - Death sentence imposed
  - Turns out examiner was WRONG!
Courts rejected the testimony of firearms examiners

“We are being viewed less and less as Hi [sic] Priests. . . . We are putting the courts in an increasingly difficult position. We ask that they believe us when we testify about individualizations. They ask us to tell them why they should. We respond with the usual subjective and Art [sic] form answers. They reject them.”

-- Letter, John Murdock and Al Biasotti to Lucien Haag, President, AFTE (Association of Firearms & Toolmark Examiners)
July 22, 1985
A committee is convened to address the problem

Murdock & Biasotti:
• “Is there a way that we can provide answers more acceptable to both our members and the courts?”
• “Many people are turned off by the need for the sophisticated research [required to establish objective criteria]. Many of our members, including myself, don’t understand all of it.”

Haag:
• “[T]he problems are real. . . . Transcripts of diverse and confusing explanations of our ‘science’ (trade, skill, art – which is it?) will emerge.”
Four years later…

The results of the Criteria for Identification Committee’s work are produced in 1989:

- Recognition of subclass marks
- AFTE Theory of Identification
- Range of conclusions
Subclass characteristics

- Marks shared by a subset of firearms of the same make and model (production run)

- Like “individual” marks, produced by irregularities in the machining process

- Nothing distinctive about subclass marks that allow them to be readily distinguished from “individual” marks
Subclass v. Individual

Different guns

Different guns

Different guns

Same gun

Same gun

Same gun
In other words…

Subclass marks are by all appearances “individual” marks that turn out not to be individual after all.
Changes in manufacturing are decreasing “individual” marks while increasing subclass marks

- “[M]ass production of guns has replaced hand-manufacturing” *US v. Mouzone*
- Manufacture under “precisely controlled” conditions imparts “recurring patterns” of marks. D. Baldwin, *Statistical Tools*
- Tools used to create firearms have become more durable, enabling their use in ever-larger production runs. P. Kirk, *Crime Investigation*
Even FATM examiners recognize a potential problem.

“As techniques of firearms manufacture have evolved, following mostly commercial rather than forensic arguments, this hypothesis [of uniqueness] needs to be verified on a regular basis.” M.S. Bonfanti & J. De Kinder
Warning signs that the problem is real

- Studies show that bullets and cartridge cases fired from different weapons can and sometimes do have more matching marks than bullets fired from the same weapon. (Miller)
- As federal databases have grown, known non-matches have appeared closer to the top of the candidate list than known matches
Anecdotes about “troubling” subclass marks abound

What did AFTE do to address the subclass issue?

NOTHING!

- No real guidance on what a subclass mark might look like
- No reference files of subclass marks
- No requirements that examiners learn about subclass marks
- No standards to reduce the effects of subclass influence
No gun recovered situation

- Heightened risk of mistaking subclass for individual marks
- “It is not uncommon … for the examiner to write a report that states that sufficient microscopic agreement is present to suggest that the same tool made the series of toolmarks, but that a conclusive opinion can be rendered only after an examination of the responsible tool.” Sci. Issues at 605.
AFTE Theory of Identification

• Identification opinions can be rendered when there is “sufficient agreement” between toolmarks.

• “Agreement is sufficient when it exceeds the best agreement demonstrated between toolmarks known to have been produced by different tools and is consistent with agreement demonstrated by toolmarks known to have been produced by the same tool.”

• When agreement is “sufficient”, the likelihood of a coincidental match is “so remote as to be considered a practical impossibility.”

• Whether agreement is “sufficient” is left entirely to the examiner’s subjective judgment.
In other words…

The examiner is told to think back to the best matching non-match she can remember. If she can’t remember a better match than what she is seeing now, then it’s practically impossible the match is coincidental.
Think back to the comments by the committee head . . .

Murdock:

Is there some way we can come up with answers without doing research?

JUST GIVE EVERYONE THE SAME ANSWER: SUFFICIENT AGREEMENT
No research : No objective standards

- NO organized study of subclass marks associated with different firearms
- NO organized study of subclass marks associated with different manufacturing methods
- NO organized study establishing how many marks are “sufficient” to individualize
- NO requirement that FATM examiner understand manufacturing processes used
- NO requirement that FATM examiner test fire other firearms of same make and model
Range of conclusions

- **Identification**: “sufficient agreement” of individual characteristics; all class characteristics match

- **Elimination**: examiners are strongly encouraged to reserve for situations where it is evident the bullet or cartridge case was fired by a firearm of **different make and model** than the suspect firearm
Range of conclusions (cont’d)

- **Inconclusive**: “quality and character of the toolmark are lacking”
Identification, Elimination or Inconclusive?
More misidentifications

- Rickie Ross (1989)
- Willie Terion Washington (2005)
- Nanon Williams (2005)
- Jarrhod Williams (2009)
- Detroit Crime Lab 10% error rate (29 of 280)
- Errors in CTS proficiency tests
- Puerto Rico case
- North Carolina case
- Lucien Haag (AFTE pres.) references misid’s he is aware of and says Murdock knows of others
Hamby and Brundage
Ten Gun Study

- FATM examiners and the government frequently cite this study as evidence that FATM examiners can accurately match bullet/cartridge case to gun under the most difficult possible conditions.

- The most difficult possible conditions are approximated by bullets fired from consecutively manufactured firearms.
Many problems have been identified with this study

- Number of guns studied (10) is too small to be meaningful
- Only one type of firearm was studied, and one type of ammunition – and that one firearm was manufactured in 1985, before updates to the manufacturing process.
- Bullets were fired into a water tank, so they were not damaged as they often are in casework
- The study is a “subjective evaluation” without documentation, such as photography, and thus is “only of value to the examiner who conducted the study.” Biasotti and Murdock
- The study’s author – James Hamby – is a far cry from the objective scientist, having been fired from his role as director of a forensic laboratory for influencing forensic technicians to withhold information regarding testing irregularities and for concealing improper testing protocol.
More problems with 10 gun study

- Most importantly, testing was unblind, meaning that test takers knew the exact nature of the test – a consecutive barrel study with no “extra” non-matching bullets.
- Adding participants to the study – the original study included 67 participants, and now the number of participants exceeds 600 – does nothing to fix the problems with its validity.
Two NAS Reports
“The validity of the fundamental assumptions of uniqueness and reproducibility of firearms-related toolmarks has not yet been fully demonstrated” (p. 3)

“A significant amount of research would be needed to scientifically determine the degree to which firearms-related toolmarks are unique or even to quantitatively characterize the probability of uniqueness.” (p. 3)

Characterizing firearm/toolmark identification as “part science and part art form” (p. 55)
“[T]here is a substantial debate within the scientific community, as well as the Courts, regarding the degree to which firearms toolmark identification evidence passes muster,” and “in this debate . . . the latest scientific consensus is as expressed in the NRC Forensic Science Report.” United States v. Mouzone, Crim. No. WDQ-08-086, 2009 WL 3617748 at *17, *28 (D. Md. Oct. 29, 2009)(emphasis added).
The consensus expressed by the NRC Committee

“The committee agree[d] that class characteristics are helpful in narrowing the pool of tools that may have left a distinctive mark,” but concluded that FATM has yet to establish “the capacity to consistently and with a high degree of certainty support conclusions about ‘individualization.’”

Report at 87; 154
“Because not enough is known about the variabilities among individual tools and guns, we are not able to specify how many points of similarity are necessary for a given level of confidence in the result. Sufficient studies have not been done to understand the reliability and repeatability of the methods.” (p. 154).
The lack of a specific protocol for toolmark analysis is a “fundamental problem,” and the toolmark analysis guidance provided by the AFTE lacks specificity because it allows an examiner to identify a match based on “sufficient agreement.” (p. 155)
Important FATM cases

- *Commonwealth v. Pytou Heang*, 2011 Mass. LEXIS 26 (2011) (cannot say scientific or practical certainty; must adequately document; must articulate differences b/t marks
Important FATM cases, cont.

- *U.S. v. St. Gerard*, (U.S. Army Tr. Judiciary, 5th Judicial Cir. June 7, 2010), (“the subjective nature of the process, lack of quantitative standards, and limited scope of foundational testing do not demonstrate the scientific principles necessary to establish the origin of the marks with *any specific amount of certainty*.”). *See also Unofficial Tr. at 1178:9-21:

  PROS: In a previous 39 Alpha, you stated, I believe, what I understood to be that Mrs. Sevigny could not discuss the level of certainty that there’s a match between the cartridge case and the firearm; but that she could at least state that she found a match. Is that a correct understanding?

  MJ: That is not. The court’s intent is to allow this witness to testify that the markings are consistent; that they’re similar; that-- However she wants to describe them; that she saw 40 striations that matched 40 other striations; that they *could have come from this weapon*; they’re consistent with what she sees. *But for her to definitively say, “And I found that they came specifically from this weapon,” is expressly excluded.*
CARTRIDGE CASE WORKSHEET

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<th>1, 2, 3, 4, 5, 6</th>
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<tr>
<td>CALIBER</td>
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<td>BRAND</td>
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NOTES:
- Items 1, 2, 3, 4, 5, 6 caliber = .22 L.R. Primer = RF
- Items 1, 2, 3, 4, 5, 6 ID to FEB #0-00325/RF Item 1 Pistol (TF 51)
What prosecution experts say

- I matched this bullet to that gun, based on corresponding marks, and I am absolutely, 100% certain no other gun would produce the same marks.

- *More recently:* I matched this bullet to that gun, based on corresponding marks, and to a reasonable degree of scientific certainty no other gun would produce the same marks.

- *Most recently:* exchange “reasonable degree of scientific certainty” for “reasonable degree of certainty in the field of firearms and toolmarks” or “practical certainty”.
What scientists have found can reliably be said

No more than: Based on the class characteristics that I observed, I cannot exclude this firearm from having fired this bullet/cartridge case.