Toolmark Identification
NAS Presentation

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Questions Posed

- What is the state of the art?
- Where is research conducted?
- Where is it published?
- What is the scientific basis that informs the interpretation of the evidence?
- Where are new developments coming from?
- Major problems?
- What research would I like answered?

What is the state of the art?

State of the art in toolmark (and firearm) identification is that the discipline is strong. It is a long, well-established discipline in forensic science and is constantly being validated. Let us remember and not lose sight of the fact that it was the comparative disciplines, specifically firearm identification, that established the crime laboratories in the United States.

Types of Marks

- Impressions
- Striations
- Combination Marks: Impressed & Striated

Two Propositions in TM Identification

- Proposition 1- states that class and microscopic marks imparted to objects by a **different tool** will rarely, if ever, display agreement sufficient to lead a qualified examiner to conclude the objects were marked with the same tool. That is, a qualified examiner will rarely, if ever, commit a false-positive error (mis-identification). This can be termed as one of our basic claims.

Propositions (continued)

- Proposition 2 - states that most manufacturing processes involve the transfer of rapidly changing random microscopic marks onto barrel bores, breech faces, firing pins, screwdriver blades, chisels, and the working surfaces of other common tools. This is caused principally by the phenomena of wear and chip formation, or by electrical/chemical erosion. Microscopic marks on tools may then continue to change from further wear and/or abuse. This can be termed our basic hypothesis, in that, it explains the fact or phenomenon that comprises Proposition 1.

Basis of TM Identification

- The basis of a toolmark identification is founded on the principle of uniqueness, wherein, all objects are unique to themselves and thus can be differentiated from one another. Additionally, the underlying mechanism for the origination of toolmarks is that when a harder object (the tool) comes in contact with a softer object (work piece), the harder object will impart its marks or features on the softer object.

Basis and Mechanism

- The basis and mechanism for identification are founded on well-established principles derived from the physical sciences that include physics, metallurgy, metallography and materials science, as well as many properties presently used in mechanical and industrial engineering.

Production of Toolmarks

- The working edges, of tools, that include components of firearm that contact ammunition, generally consist of some type of hard material, such as steel, to ensure strength and durability of the tool; while work pieces are generally made of softer materials. These surfaces of a tool that contact a material contain certain random, microscopic irregularities that are produced during the tool's manufacture and/or subsequent wear through use and abuse.

Uniqueness of Toolmarks

- These irregularities which are formed randomly, are considered unique and can individualize or distinguish one tool from another. Because these individual characteristics are typically imparted onto the work piece, the comparative study of the imparted markings allow the tool to be individually identified as having produced the mark.

Method

- The most widely used and accepted method in conducting toolmark examination is a side-by-side, microscopic comparison of the markings on a questioned material item to known source marks imparted by a tool. This method (comparing knowns to unknowns) is widely used by other comparative disciplines.

Examination Process

- The examination process used in Toolmark Identification is similar to those used in the other comparative disciplines in forensic science. This process begins with a study of the most general characteristics (class) of items to be compared, progressing through (subclass) to the analysis and comparison to the most specific characteristics (individual).

Association/Identification

- Any individual association or identification conclusion effected through this examination process (just mentioned) results from the practical certainty based on the underlying (validated) scientific theory.

Scientific Foundation Established

- Discipline firmly rooted in application of the Scientific Method.
- Repeated testing of hypotheses related to identification has been performed.
- Has resulted in standard statement settings guidelines for defining identification criteria.

AFTE Theory of Identification

- The Association of Firearm and Tool Mark Examiners (AFTE) established in 1969.
- AFTE Journal, peer-reviewed publication, generated four times annually.
- Annual seminar hosted; an international organization.
- Has a certification program; published standards (i.e., glossary, training manual and the Theory of ID).

AFTE Theory of Identification*

- IS a standard defining identification criteria;
- is established as a theory based on principles of the scientific method;
- is a statement of the relevant scientific community, but
- has not been referenced by any recent criticisms/challenges.

* Theory of Identification, Range of Striae Comparison Reports and Modified Glossary Definitions – an AFTE Criteria for Identification Committee Report. *AFTE Journal*, 24(2), April 1992, 336-340.

AFTE Theory of Identification

- Addresses issues of common origin
- Defines observational objectives
- Defines sufficiency of agreement to establish common origin, i.e., identification criteria
- Defines meaning of identification
- Defines role of subjectivity

Common Origin

- “The theory of identification as it pertains to the comparison of tool marks enables opinions of common origin to be made when the unique surface contours of two tool marks are in ‘sufficient agreement’.”

Observational Objectives

- “Specifically, the relative height or depth, width, curvature and spatial relationship of the individual peaks, ridges and furrows within one set of surface contours are defined and compared to the corresponding features in the second set of surface contours.”

Identification Criteria

- "Agreement is significant when it exceeds the best agreement demonstrated between tool marks known to have been produced by different tools and is consistent with the agreement demonstrated by tool marks known to have been produced by the same tool."

What an Identification Means

- "The statement that 'sufficient agreement' exists between two tool marks means that the agreement is of a quantity and quality that the likelihood another tool could have made the mark is so remote as to be considered a practical impossibility." It is an **individualized association**.

Subjectivity

- "Currently the interpretation of individualization/identification is subjective in nature, founded on scientific principles and based on the examiner's training and experience."

Scientific Foundation/Method Problems?

- There are none or few, as far as the practitioner is concerned.
- However, there are questions/challenges raised in Daubert-related cases.
- CMS Method vs Traditional Pattern Matching

Challenges/Daubert Criteria

- Testability of Scientific Principle
- Known or Potential Error Rate
- Peer Review and Publication
- Maintenance of Standards and Controls
- General Acceptance in a Particular Scientific Community

Testability of Scientific Principle

- Scientific testing is a procedure for critical evaluation of scientific methodology. The methods applied to the microscopic comparison of toolmarks has been tested and re-tested over the course of the discipline's long history.

Known or Potential Error Rate

- Error rate is the frequency at which one deviates from a correct standard. Errors can occur through individual oversight or as a result of the deviation from a particular method. The forensic toolmark and firearm identification community participates in validity and proficiency testing from which error rates can be calculated.

Peer Review and Publication

- Peer review is the evaluation of a colleague's research. Scientific journals such as the Association of Firearm and Tool Mark Examiners (AFTE) Journal, the Journal of Forensic Sciences (AAFS), the Journal for Identification (IAI), Forensic Science International and others have peer-review processes that subject written works to assigned reviewers for critique. If the work is approved by the peer's reviewer/editorial process, it is then submitted for publication.

CMS vs. Pattern Methods

- CMS used by a small group of examiners.
- CMS used only for striated marks.
- CMS ruled on in a recent CA case (US v. Edgar Diaz) where the judge in his ruling stated: “This order finds that CMS is a school of thought among a small subclass of professionals in the firearms-identification field. It has not gelled into a recognized discipline.” And that “CMS is not a new technique, nor in conflict with traditional pattern matching that has characterized the discipline from the earliest of times.”

Where is research conducted?

- At universities/colleges by students.
- By students that intern at crime laboratories.
- By practitioners at crime laboratories.
- By private entities.
- By government entities; NIJ, the MFRC (Midwest Forensic Resource Center) at Ames, Iowa.

Research Venues

- Other sciences (mathematics/statistics, electrical engineering, computer sciences) become involved, so as to strengthen/support and verify the discipline.
- New studies invariably support what has been conducted historically.
- Basic pattern recognition is done with the human eye. At the present time pattern recognition cannot not been replaced, but it is supported, with instrumentation (IBIS, AFIS, etc.).
- Practitioners have to be involved with the researchers, so as to have checks and balances in the process. There are many levels of expertise that are needed for validation.

Research Questions in TM?

- None; just that it be conducted.
- Difficult to conduct with the emphasis on casework (applied vs. basic research laboratory a consideration/feasible?).
- Future research to be conducted will continue to validate the science.
- Examiners must be trained and research conducted with court-qualified examiners.
- Research be conducted with researchers **and** practitioners.

Recommendations/Trend

- Traditional training employed; that it be more progressive.
- TM examiner is not a technician, but a scientist.
- More emphasis in court training, i.e., articulation.
- More emphasis in Daubert criteria/issues.
- More standardization in casework documentation.
- Research continue to be conducted to support and validate the discipline.

In Conclusion

- Thank you for the opportunity to attend...
- Questions??