Communicating Forensic Findings: Current Practices and Future Directions Workshop

Trace Evidence Perspective on Interpretation Scales

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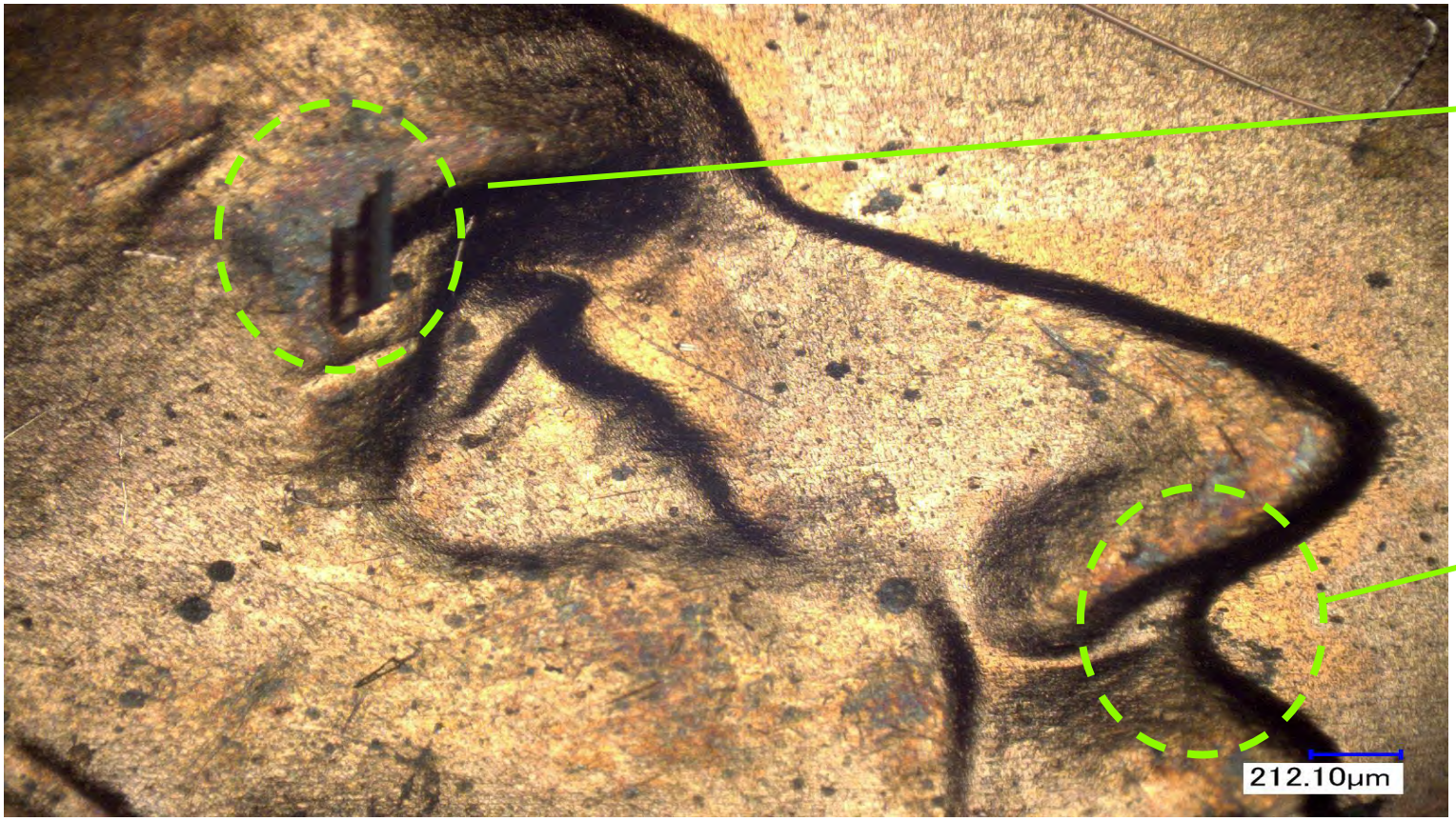
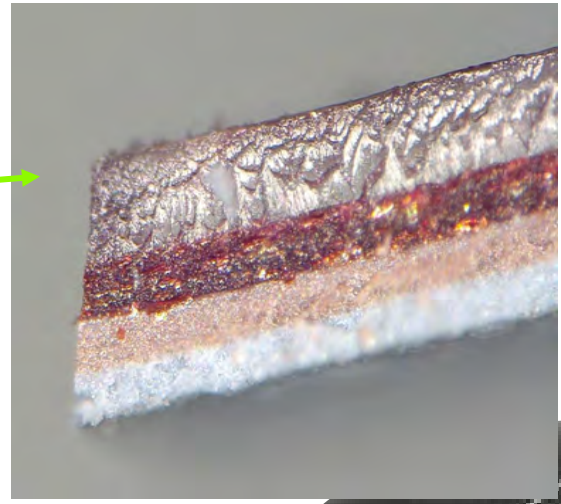
June 25-26, 2024; Rockville, Maryland

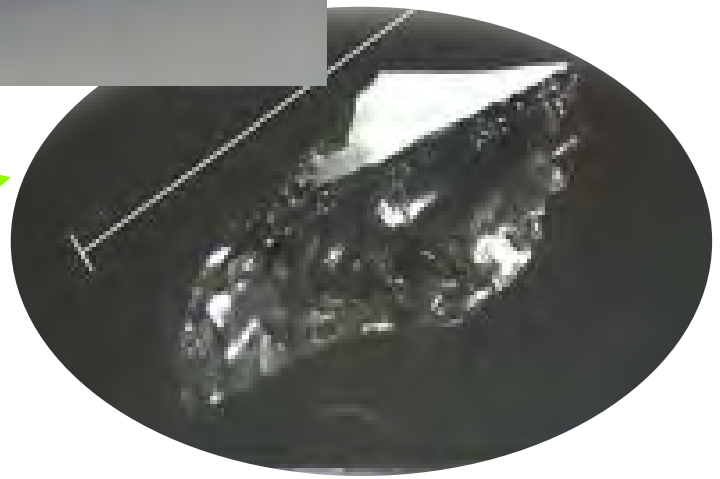
OSAC Organization of Scientific Area Committees for Forensic Science

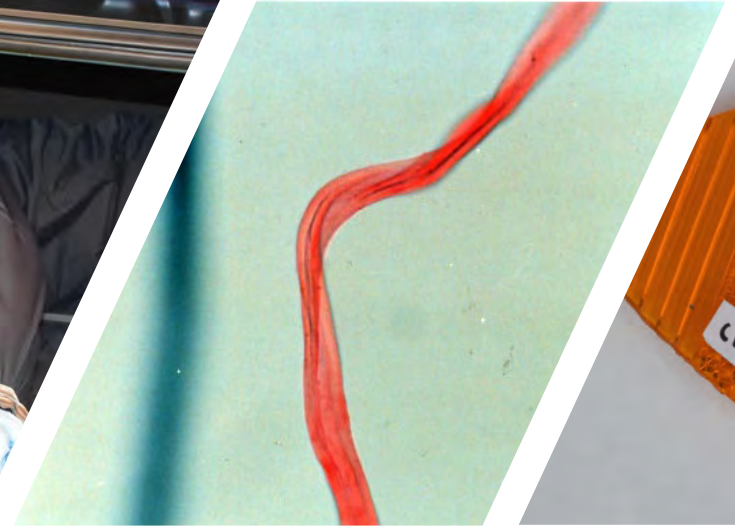
West Virginia University

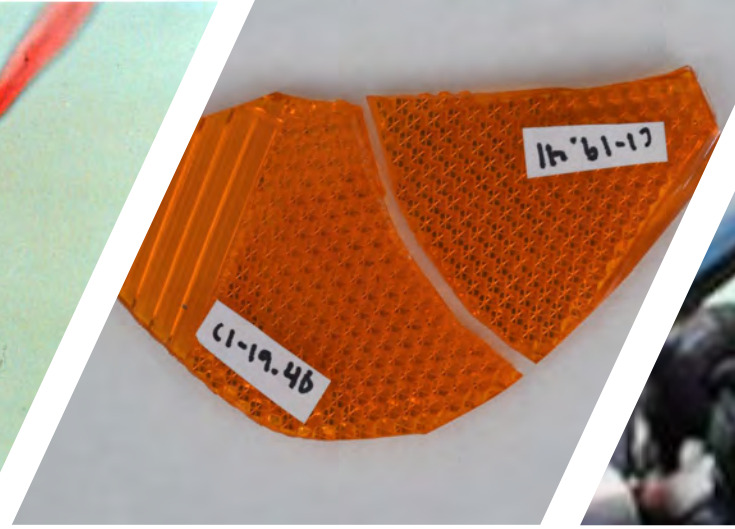
TRACE evidence: invisible clues that tell a story…









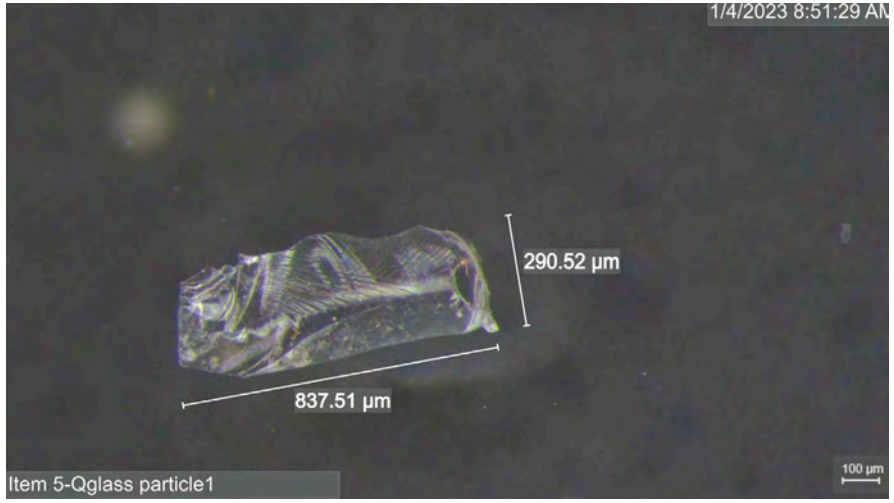


Links between objects can answer questions about when, how, where?

Images:

- https://depositphotos.com/stock-photos/car-crash.html
- https://www.la-criminaldefense.com/drive-by-shooting-murder-gang-defense-in-california/

Hit and run case example

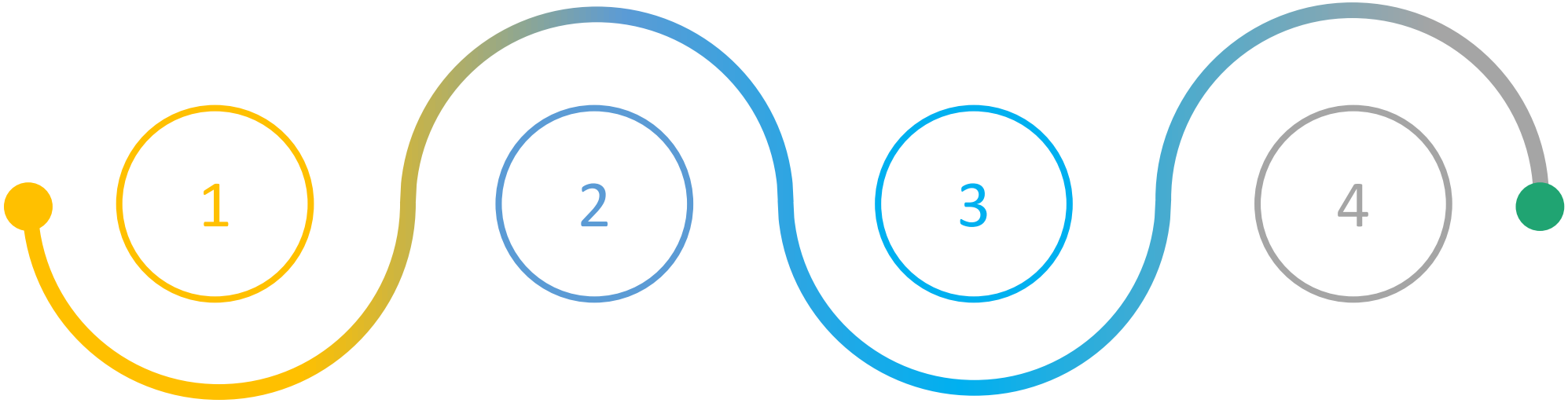


Courtesy of Troy Ernst, Trace Evidence Unit, Forensic Science Division, Michigan State Police

Not too long ago…

"The glass fragment recovered from the jacket (item #5) **could have come from** the glass submitted as reference (mirror item #6)"

Initiatives in Trace Evidence: Interpretation Scale Development



2006

ORIGIN: Michigan State Police, Chris Bommarito

2008-2014

SWGMAT
Some versions implemented at forensic laboratories (as seen in proficiency test results or surveys)

2014-to date

NIST-OSAC Trace Subcommittee, Interpretation task group

OSAC 2022-S-0029 Standard Guide for Interpretation and Reporting in Forensic Comparisons of Trace Materials

Standard Guide: SUBMITTED TO ASTM

Interpretation & Reporting Guide

Interpretation Task Group Members, past and present

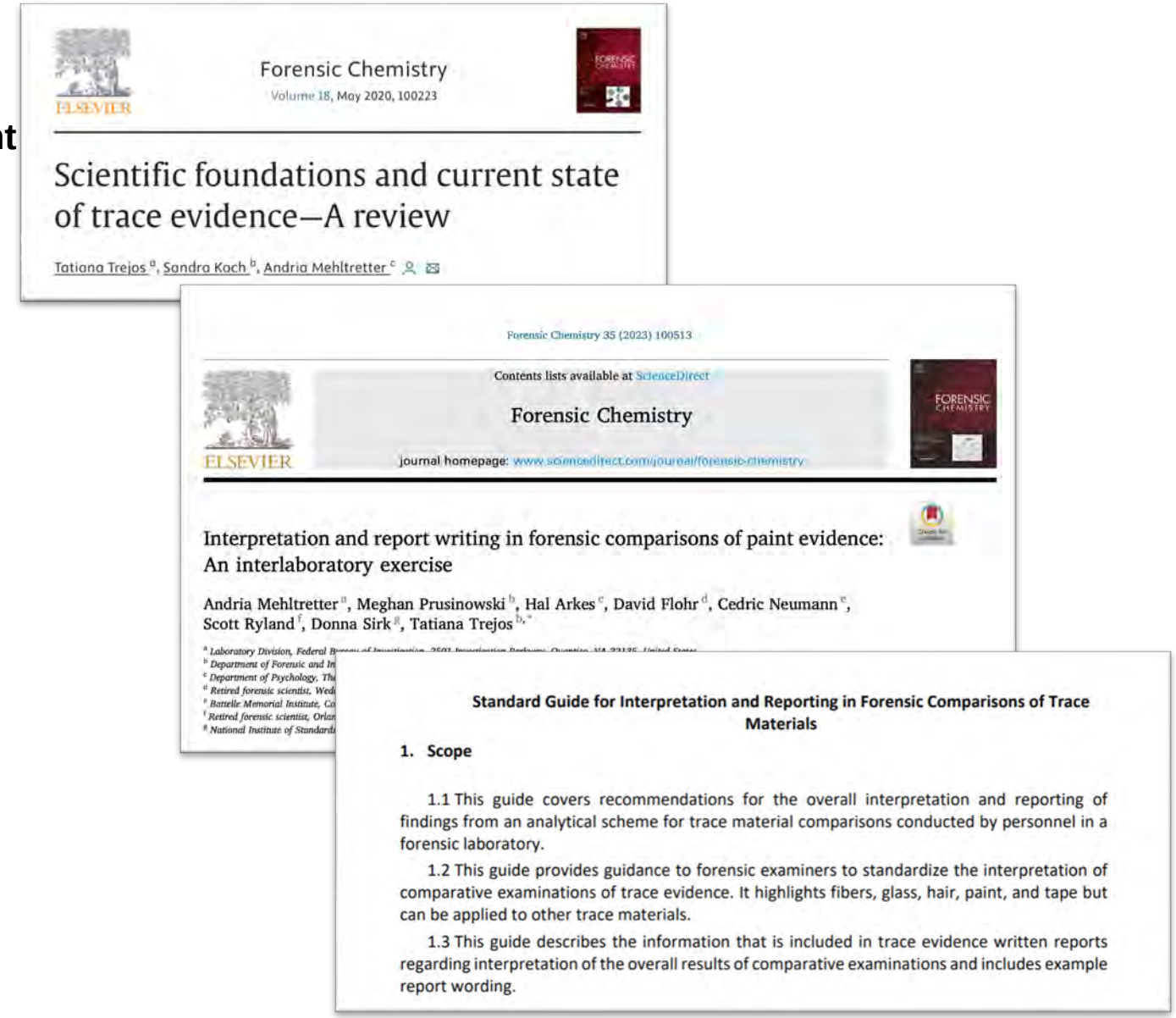
- Cathy Brown, Collaborative Testing Services (current chair)
- Mary Eng, New York City Police Crime Lab
- David Green, Lake County Crime Lab (Ohio)
- Susan Gross, Minnesota Bureau of Criminal Apprehension, ATF
- Tammy Jergovich, Georgia Bureau of Investigation
- Cheryl Lozen, Michigan State Police, retired
- Andria Mehltretter, FBI (past chair)
- Tatiana Trejos, West Virginia University

Statisticias and human factors (Hal Arkes, Cedric Newmann, Madeline Ausdemore , Shirly Montero

NIST-OSAC Trace/Materials Subcommittee

Revisions at Subcommittee, STRP panel, Legal & Human Factors, FSSB

Hundreds of reviewers: OSAC and public



Forensic Chemistry
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Scientific foundations and current state of trace evidence—A review

Tatiana Trejos [a], Sandra Koch [b], Andria Mehltretter [c]

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Interpretation and report writing in forensic comparisons of paint evidence: An interlaboratory exercise

Andria Mehltretter [a], Meghan Prusinowski [b], Hal Arkes [c], David Flohr [d], Cedric Neumann [e], Scott Ryland [f], Donna Sirk [g], Tatiana Trejos [b,*]

Standard Guide for Interpretation and Reporting in Forensic Comparisons of Trace Materials

1. Scope

1.1 This guide covers recommendations for the overall interpretation and reporting of findings from an analytical scheme for trace material comparisons conducted by personnel in a forensic laboratory.

1.2 This guide provides guidance to forensic examiners to standardize the interpretation of comparative examinations of trace evidence. It highlights fibers, glass, hair, paint, and tape but can be applied to other trace materials.

1.3 This guide describes the information that is included in trace evidence written reports regarding interpretation of the overall results of comparative examinations and includes example report wording.

Interpretation Guide

Simple Interpretation Process for Comparative Examinations

- 5 main subdisciplines: fibers, hair, glass, paint, and tape.
- Can the compared items be discriminated?
- Evaluation of the results on a source level. Common source? Significance of the finding?
- Evaluation of these results considering various factors
- Also compatible with LR

✓ Uses a scale to assess and report the significance of the findings

✓ Provides material-specific interpretation criteria and casework-based reporting examples

✓ Universal and flexible platform can use scientifically sound qualitative or quantitative inputs for decision-making

The Core of the Guide:
Interpretation categories based on systematic approaches and consensus criteria

SYSTEMATIC CRITERIA

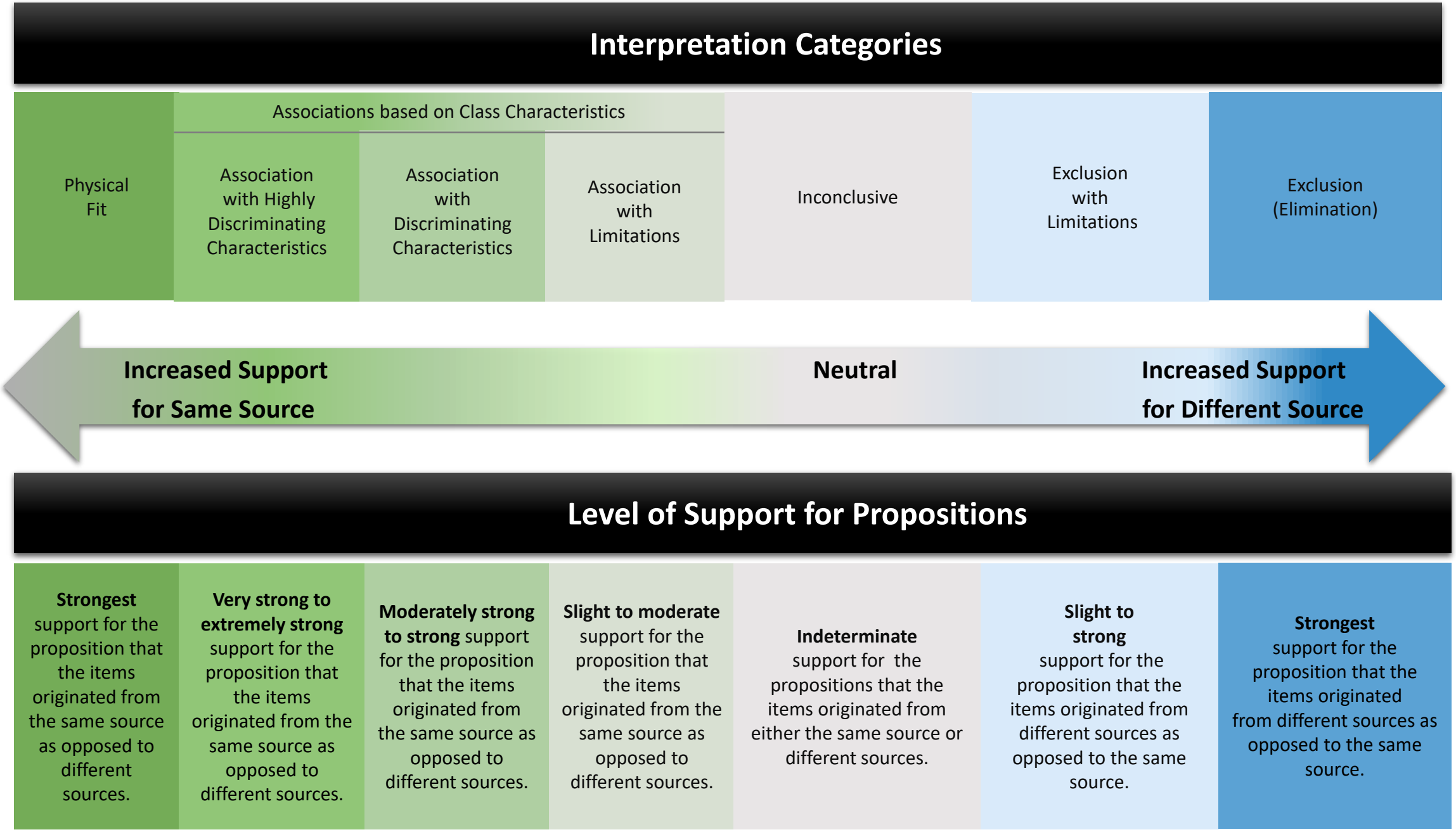
Interpretation based on:

- ✓ Scientific foundations
- ✓ Analysis and Data Interpretation
- ✓ Rarity assessment
- ✓ Contextual relevance
- ✓ Population studies (what is out there?)
- ✓ Manufacturing and distribution information
- ✓ Discrimination studies
- ✓ Practitioner training and experience
- ✓ Case studies
- ✓ Databases and collections

Criteria developed by material supported by hundreds of scientific literature.

- Casework-based example
- Realistic, practical
- Evaluated under various data/information inputs/criteria to support interpretation

- **Physical Fits**
- **Associations with highly discriminating characteristics (AHD)**
- **Associations with discriminating characteristics (AD)**
- **Associations with limitations (AL)**
- **Inconclusive (IN)**
- **Exclusion with limitations (EL)**
- **Exclusion (EX)**


Interpretation Categories
Physical Fit
Associations based on Class Characteristics
Association with Highly Discriminating Characteristics
Association with Discriminating Characteristics
Association with Limitations
Inconclusive
Exclusion with Limitations
Exclusion (Elimination)
Increased Support for Same Source
Neutral
Increased Support for Different Source
Level of Support for Propositions
Strongest support for the proposition that the items originated from the same source as opposed to different sources.
Very strong to extremely strong support for the proposition that the items originated from the same source as opposed to different sources.
Moderately strong to strong support for the proposition that the items originated from the same source as opposed to different sources.
Slight to moderate support for the proposition that the items originated from the same source as opposed to different sources.
Indeterminate support for the propositions that the items originated from either the same source or different sources.
Slight to strong support for the proposition that the items originated from different sources as opposed to the same source.
Strongest support for the proposition that the items originated from different sources as opposed to the same source.

Exclusion

- **Exclusion (Elimination)** – The items exhibit differences that provide the strongest support that the items originated from different sources as opposed to the same source.

Exclusion with Limitations – The item exhibits differences from the comparison sample that support that it did not originate from the source, as represented by the comparison sample; however, limiting factors prevented an Exclusion (Elimination) from being reached. This provides slight to strong support for the proposition that the items originated from different sources as opposed to the same source.

Arson- Molotov cocktail fabric: Exclusion

Courtesy of Troy Ernst, MSP.

Physical fit

Physical Fit is the highest degree of association between items. It is the opinion that the observations provide the strongest support for the proposition that the items were once joined together to form a single object as opposed to originating from different sources. *Physical Fit* is reached when the items that have been broken, torn, or separated exhibit physical features that correspond or re-align in a manner that is not expected to be replicated. A Physical Fit is not currently based upon a statistical evaluation of data; it is also not based upon exhaustive comparisons to all potential sources.

Physical Fit: Fatal hit and run case- MSP

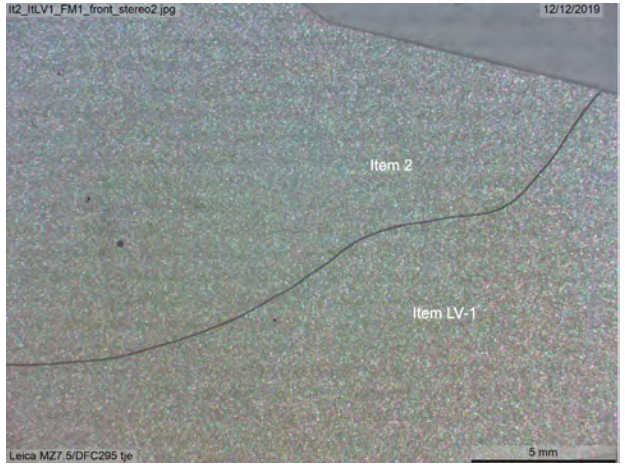
Police find vehicle parts near Norton Shores hit-and-run victim

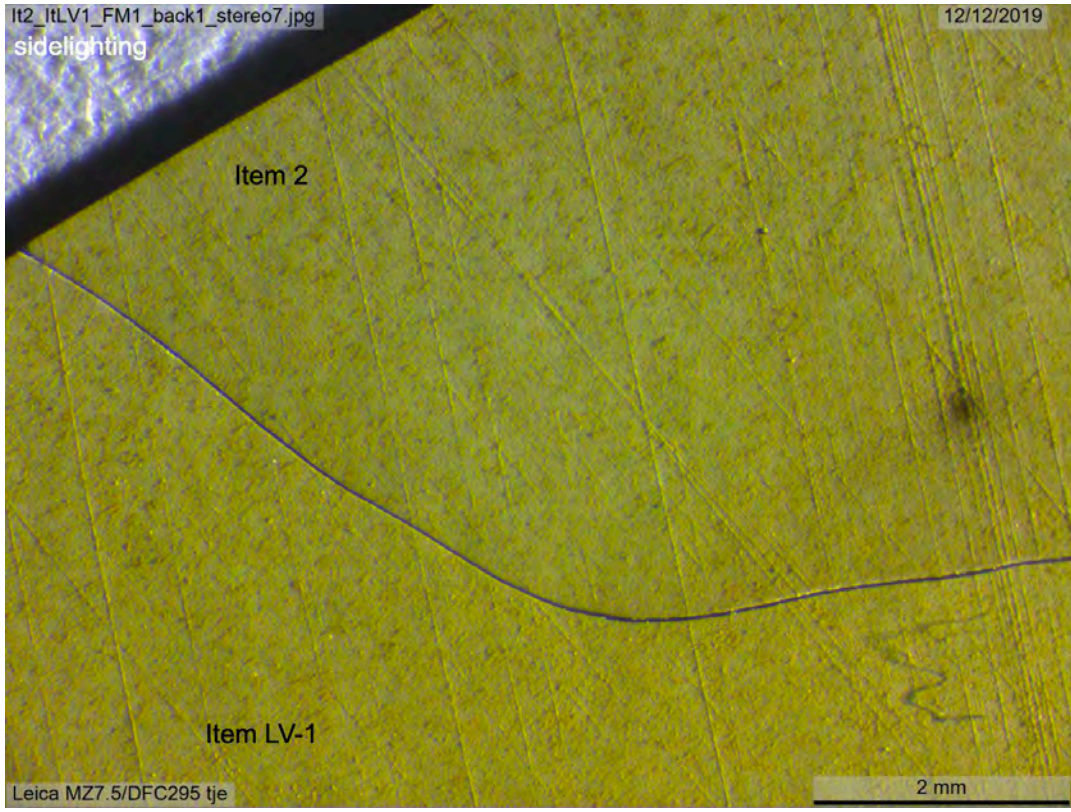
By: FOX 17 News

Posted at 9:35 AM, Nov 24, 2019 and last updated 9:49 AM, Nov 24, 2019

NORTON SHORES, Mich. — Police are trying to find the driver responsible for a hit-and-run that left a 53-year-old woman dead on the side of a road.

The incident happened on Seaway Dr. between W. Norton Ave. and Seminole Rd. at about 12:44 a.m. Sunday morning, according to Norton Shores Police Department. Medical crews determined the Muskegon Heights resident died at the scene.





Disclaimer: Courtesy of Troy Ernst, MSP. Conclusions are redacted to illustrate the scale and not verbatim of his report

Associations of Evidence based on Class Characteristics

Class characteristics are physical, optical, or chemical properties that establish membership in a group. Associations based on class characteristics do not establish that the items came from the same source. Class associations can have varying degrees of significance. In general, the smaller the size of the group relative to the relevant population, the more significant the association. These types of associations are categorized as follows:

- Association with Highly Discriminating Characteristics
- Association with Discriminating Characteristics
- Association with Limitations

Association- glass example

Association with Highly Discriminating Characteristics

The items share unusual characteristics that would rarely occur in the relevant population.

- Association of glass fragments characterized by elemental analysis using **ICP-based** methods.
- Association of glass fragments characterized by **RI and elemental analysis using µXRF when Sr, Zr, or an element that is less commonly or rarely detected** in glass by XRF is used in element intensity ratio comparisons.
- Association of glass fragments for which the estimated **random match probability of the measured properties is very small (i.e., smaller than 0.2%)**
- Association of glass fragments for which the estimated calibrated likelihood ratios (LR) provide very strong to extremely strong support for the same-source hypothesis over the different-source hypothesis (e.g., **LR greater than 1000**)

Association with Discriminating Characteristics

Other items have been manufactured or could occur in nature that would also be indistinguishable from the submitted items and could be encountered in the relevant population

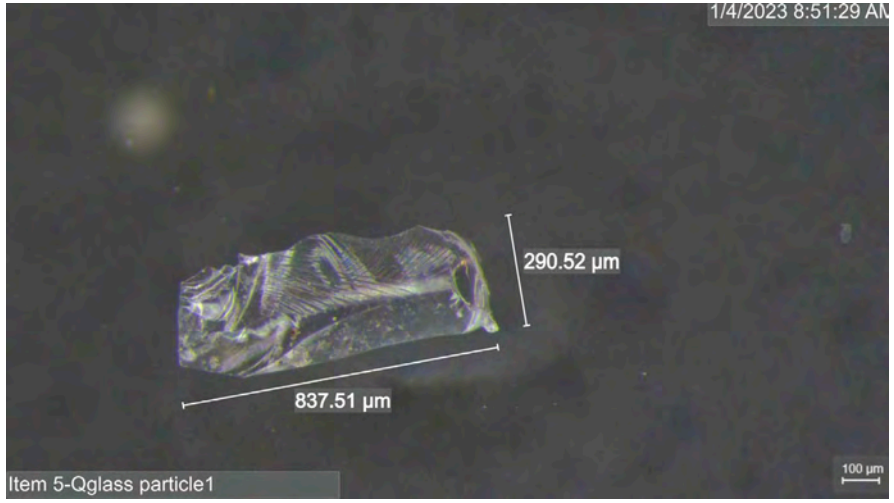
Association of glass fragments characterized by **elemental analysis using µXRF alone**, when Sr, Zr, or an element that is less commonly or rarely detected in glass by is used in element intensity ratio comparisons.

Association of glass fragments characterized by elemental analysis using RI and µXRF, when Sr, Zr, and all elements that are less commonly or rarely detected in glass by XRF are below the limit of quantitation.

Association of glass fragments for which the estimated **random match probability of the measured properties is small (e.g., between 0.2% and 2%)**

Association of glass fragments for which the estimated calibrated likelihood ratios (LR) provide moderately strong to strong support for the same-source hypothesis over the different-source hypothesis (e.g., **LR between 100 and 1000**)

GLASS: Fatal Hit and Run Case Example

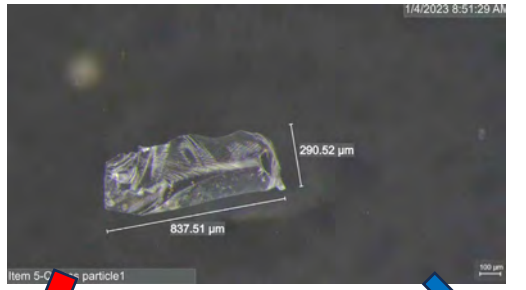


Courtesy of Troy Ernst, Trace Evidence Unit, Forensic Science Division, Michigan State Police

Hit and Run Reporting Example

- **Association with Discriminating characteristics**
- The questioned glass fragment (Item 5-Qglass) and the known glass from the large mirror of Item 2 corresponded in general appearance, refractive index, and elemental composition by µXRF.
- In the opinion of the examiner, Item 5-Qglass originated either from the large mirror of Item 2 or from another broken glass source with indistinguishable properties.(**Association with Discriminating Characteristics**). This type of association was reached because coincidental associations of glass originating from different sources could occur but are expected to be unusual.

- **Exclusion/Elimination**
- The questioned glass fragment (Item 5-Qglass) differed in elemental composition from the known glass from the small mirror of Item 2. In the opinion of the examiner, Item 5-Qglass did not originate from the small mirror of Item 2 (Elimination)



Association **Elimination**

Disclaimer: Courtesy of Troy Ernst, MSPD. Conclusions are redacted to illustrate the interpretation scale and not verbatim of his report

Association- paint example

Association with Highly Discriminating Characteristics

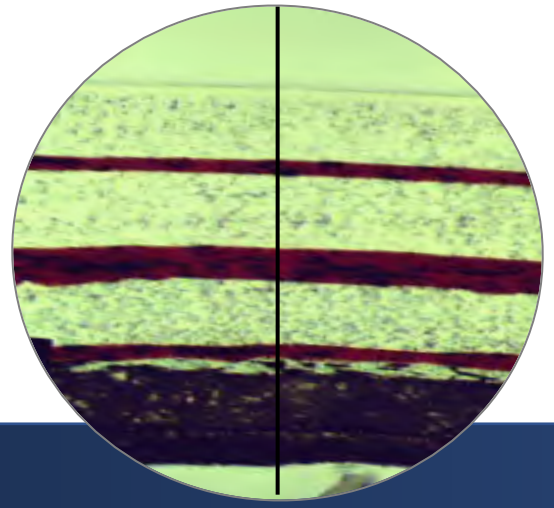
The items share unusual characteristics that would rarely occur in the relevant population.

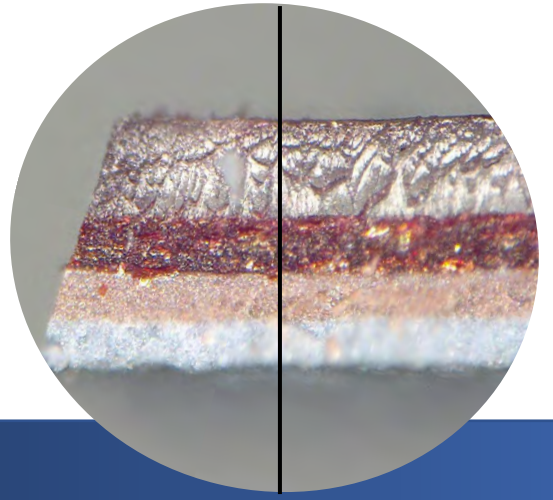
- OEM automotive system with **at least one aftermarket** basecoat or primer layer above the original clear coat.
- OEM automotive system with **two or more factory repairs** (i.e., three or more total basecoat-clearcoat sequences).
- **Architectura**l paint system with **two or more different layers**.
- Automotive system with architectural paint present.

Association with Discriminating Characteristics

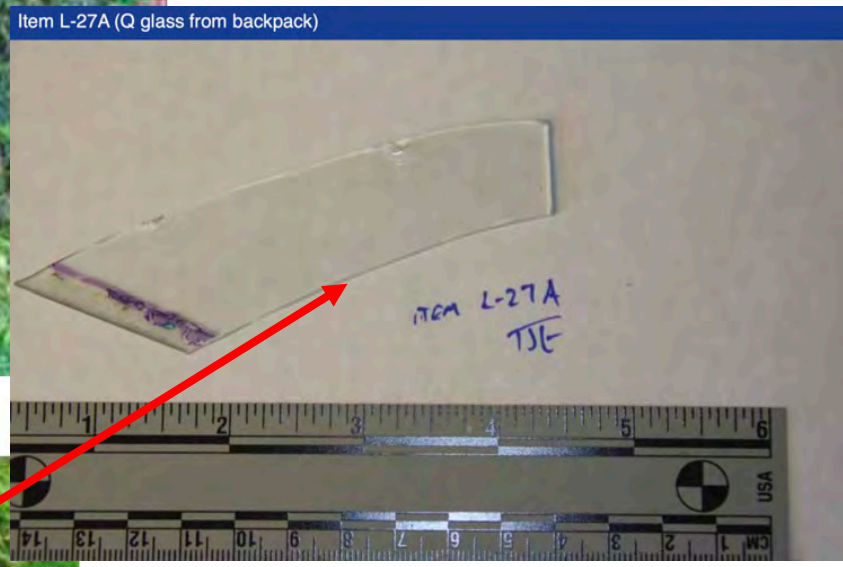
Other items have been manufactured or could occur in nature that would also be indistinguishable from the submitted items and could be encountered in the relevant population

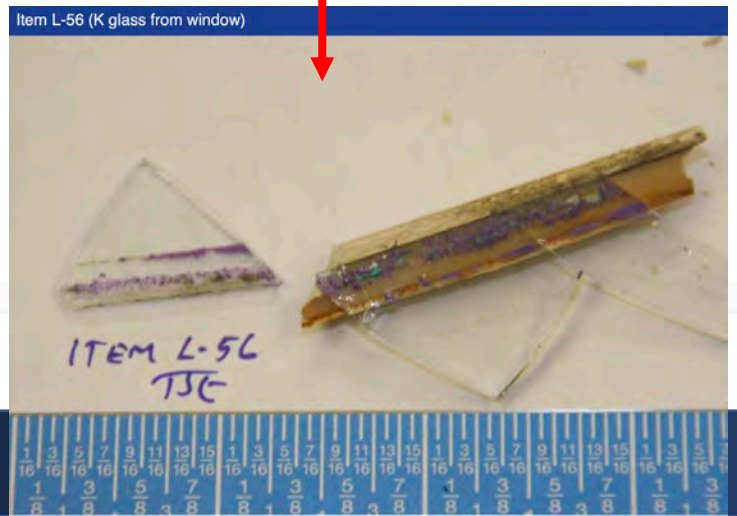
- Association of paint in which the typical analysis scheme was performed on mass- produced materials that have numerous features for evaluation (e.g., four-layered OEM automotive paint).
- **OEM automotive paint** system with one factory repair of the same basecoat color and layer sequence (i.e., two total OEM basecoat-clearcoat sequences).
- Single-layered **paint for which there is knowledge of substantial discrimination power** (e.g., red architectural paint) or product manufacturing distribution information that reduces the potential sources.
- **Aftermarket refinish clearcoat and basecoat**





GLASS and PAINT Example - Homicide

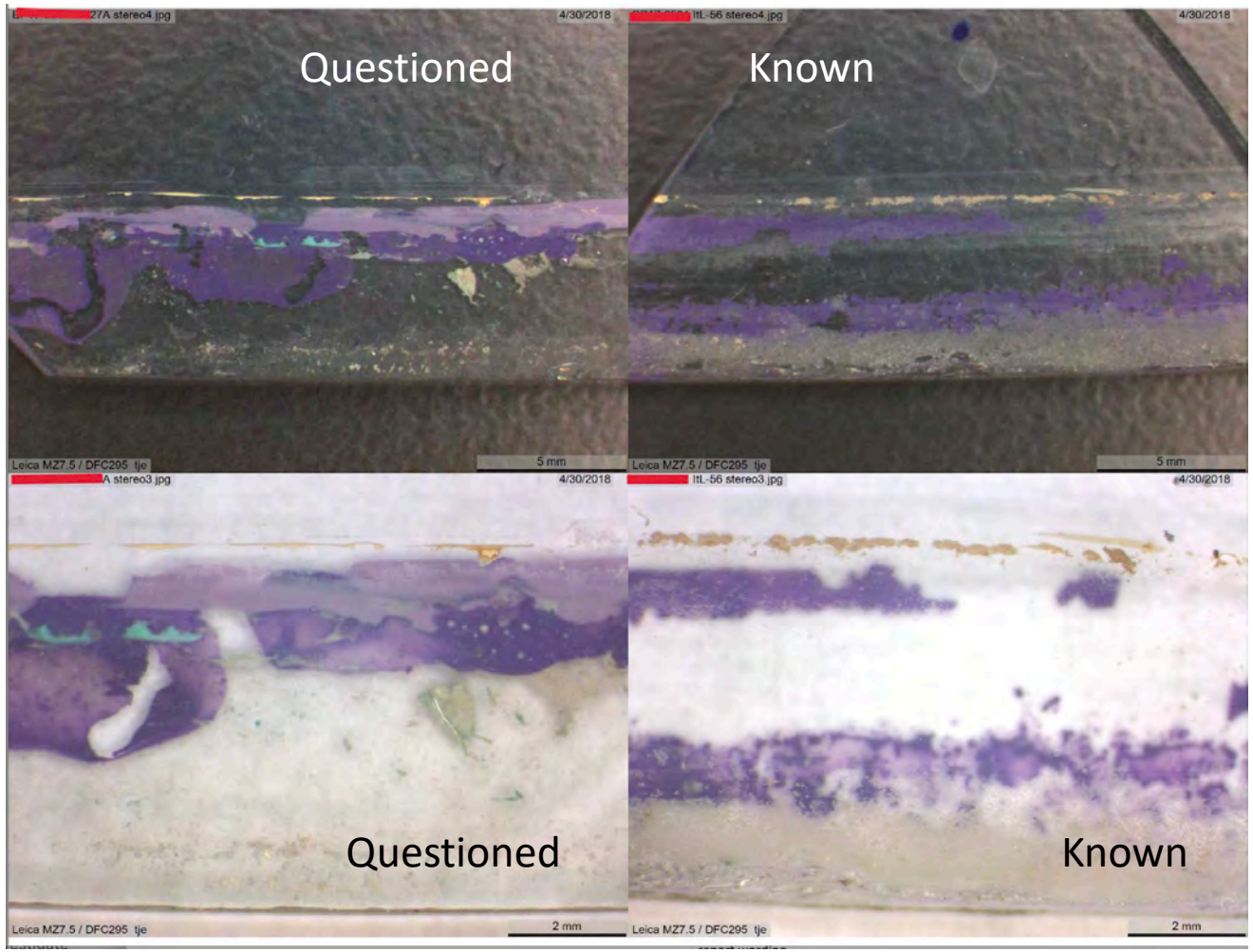




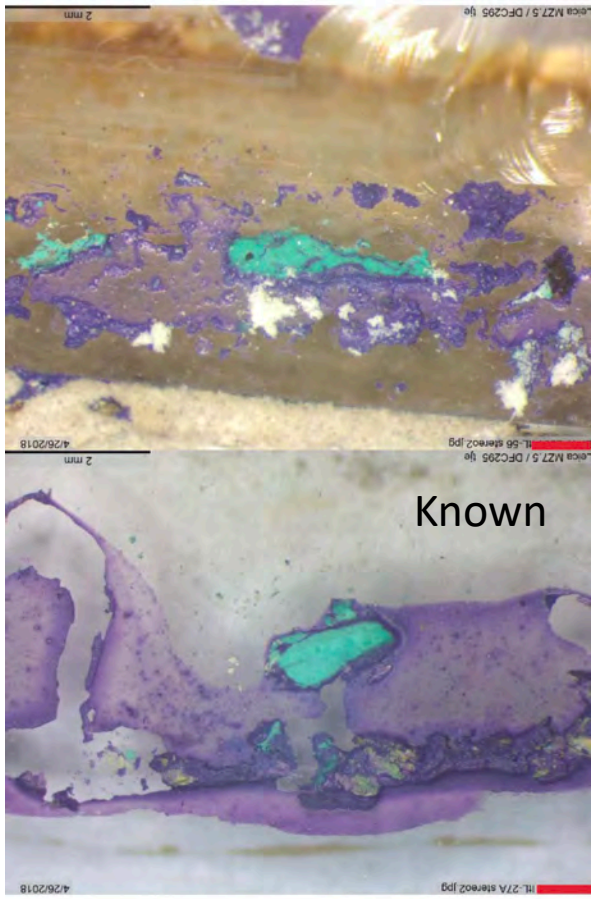
Known K
L-56

Questioned Q
L-527A

Courtesy of Troy Ernst, Trace Evidence Unit, Forensic Science Division, Michigan State Police


Questioned
Known
Questioned
Known
Leica MZ7.5 / DFC295 tje
5 mm
2 mm
4/30/2018

Questioned


Known
2 mm
4/26/2018

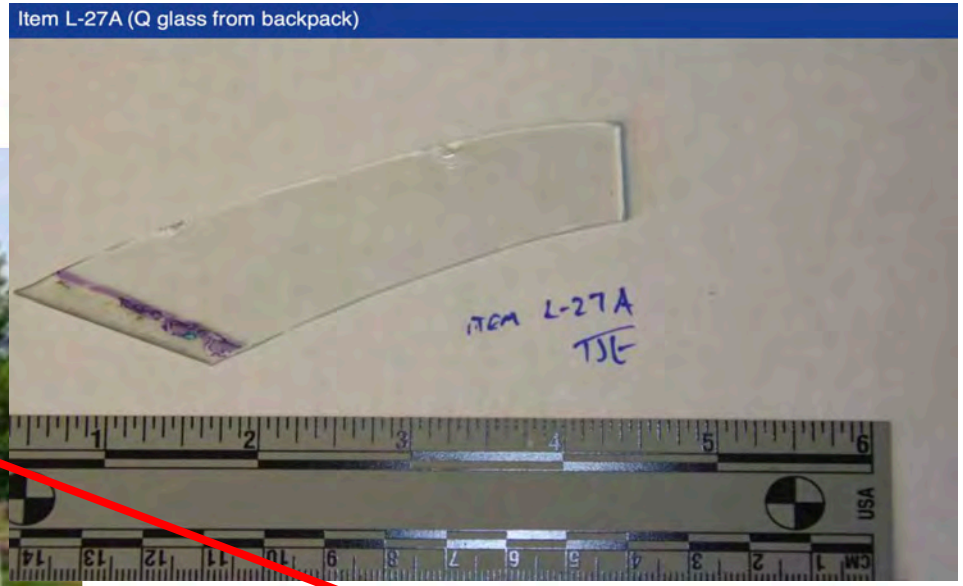
Glass and Paint Reporting Example

- **Glass Association with Highly Discriminating Characteristics**
- The submitted questioned glass fragment (Item BP17-2581-L27A) and known glass fragments (Item L-56) were compared using physical characteristics, refractive index measurements, and elemental analysis by x-ray fluorescence (XRF).
- The questioned glass fragment was similar in color, thickness, type (float, non-tempered), refractive index, and elemental composition to the known glass. Additionally, there were corresponding colors (purple and turquoise) and location of apparent paint on the surfaces of the questioned and known glass samples, and corresponding color and location of apparent caulk on the surfaces opposite the paint of the questioned and known glass samples.
- **Therefore, the questioned glass originated from the broken window as represented by the known sample or another source of broken glass indistinguishable in the measured properties (Association with Highly Discriminating Characteristics). This type of association was reached because coincidental associations of glass originating from different sources could occur but are expected to be highly unusual.**
- **The presence of corresponding multiple colors of paint and of apparent caulk on both items greatly increases the significance of this association.**

- **Paint Association with Highly Discriminating Characteristics**
- Examination and comparison of the questioned paint with known sample, revealed they are consistent with respect to their observed and measured physical and chemical properties (e.g., architectural paint with two colors, purple and turquoise paint). It is therefore concluded that the Item questioned paint recovered from the glass fragment in the bag pack corresponds to the known item paint and therefore originated either from that window or from another window with architectural paint having the same distinct characteristics (Association with Highly Discriminating Characteristics).
- **The presence of corresponding multiple colors of paint and of apparent caulk on both broken glass items greatly increases the significance of this association.**

Disclaimer: Courtesy of Troy Ernst, MSP. Conclusions are redacted to illustrate the scale and not verbatim of his report

How trace evidence strengthen links!



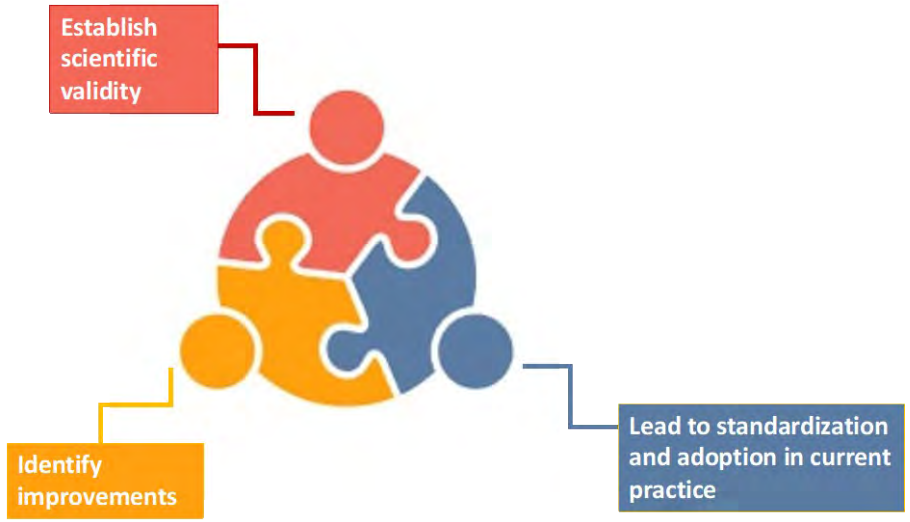
TRACE

DNA

Courtesy of Troy Ernst, Trace Evidence Unit, Forensic Science Division, Michigan State Police

Interlaboratory Study

- **Five possible levels of interpretation**
- Two difficulty levels
- 80 scenarios independently developed and evaluated by "**Subject Matter Expert Panel (SMEP**)" best 30 chosen for study
- 30 "SMEP consensus ground truth" scenarios
  - 15 scenarios randomly distributed to each participant
  - Overall, designed to have same number of total responses per scenario
  - **85 participants, 1267 responses**



Lessons learned from Paint Interpretation ILS

- These findings demonstrate that a **high level of agreement was achieved** among practitioners regarding the significance of results in comparative examinations when using the proposed guide.
- High **agreement between consensus reached by SMEP and within participants** (**93%** of the case scenarios, 28 out of 30)
- This exercise provided a **tangible means to assess the thinking process** of the participants in interpreting the results. The scale, criteria, and examples in the document aid in standardizing the interpretation process.

Acknowledgements

- Cedric Neumann, statistical support
- Hal Arkes, Emeritus Professor, Department of Psychology, The Ohio State University
- Donna Sirk, NIST-OSAC Program Office
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- David Flohr, retired forensic scientist
- Meghan Prusinowski, Korina Menking Hoggatt, former graduate students, West Virginia University
- NIST-OSAC Trace/Materials Subcommittee Interpretation and Physical Fit Task Group Members
- Interlaboratory study participants

Questions?

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