



OSAC RESEARCH NEEDS ASSESSMENT FORM

Title of research need:

Development of Quantitative Assessment and Evaluation of Error Rates in Physical Fit Determinations of Trace Materials

Keyword(s):

Trace evidence, interpretation, physical fit, fracture fit, fracture match

Submitting subcommittee(s):

Materials/Trace

Date Approved:

9/24/18

(If SAC review identifies additional subcommittees, add them to the box above.)

Background Information:

1. Description of research need:

Trace materials, such as fabric, tape, paint, plastic or glass can be broken, torn, cut or otherwise separated during different criminal activities such as homicides, kidnappings, and sexual assaults. Likewise, plastic and metal parts that hold the automotive paint can be bent during a crash or hit and run, lifting fragments of paint from the original substrate. In these events, it is possible that the fragments transferred during the violent activity physically align with the original source to form one continuous piece. If distinctive features are observed within the corresponding edges and surfaces of the questioned evidence and the known source, the forensic examiners conclude there is a physical fit among the items (a.k.a. fracture match or physical match).

It is hypothesized that random physical fits of trace materials are improbable, and therefore when found they are considered the highest degree of association that can be determined in a forensic examination.

There have been few experimental studies that have evaluated the error rates in such determinations, and there is an interest in the field to further explore ways to support the empirical observations involved in making fracture match determinations. Moreover, the conclusion of a fit between edges relies on the examiner's opinion to identify those distinctive features.

To date, there are no standard methodologies and criteria for making decisions about the presence of a physical fit and the significance of such evidence. Therefore, it is crucial to explore mechanisms to qualify and quantify physical fit features, and develop standardized methods to evaluate the quality of a fit and the error rates associated with such conclusions.

The factors affecting the evaluation and interpretation of the significance and meaning of observed features are anticipated to vary by the composition of each material (e.g., tape, fabrics, glass, paint), and as a result, independent validation studies are recommended for each trace subdiscipline as appropriate.

The results of this research are required to explore strategies to effectively qualify and quantify distinctive features in physical fit examinations and to serve as a scientific foundation to develop standard methods that complement and substantiate the examiner's opinions.

2. Key bibliographic references relating to this research need:

1. Bradley, M.J., Keagy, R.L., Lowe, P.C., Rickenbach, M.P., Wright, D.M., and LeBeau M.A., "A validation study for duct tape end matches," *Journal of Forensic Sciences*, Vol. 51, 2006, pp. 504-508.
2. Bradley, M.J., Gauntt, J.M., Mehlretter, A.H., Lowe, P.C., and Wright, D.M., "A validation study for vinyl electrical tape

- end matches," *Journal of Forensic Sciences*, Vol. 56, 2011, pp. 606-611.
3. Frederic A. Tulleners, M.A., Jerome V. Braun The Statistical Evaluation of Torn and Cut Duct Tape Physical End Matching NIJ report Award Number 2009-DN-BX-K235
 4. Baca AC, Thornton JI, Tulleners FA, Determination of Fracture Patterns in Glass and Glassy Polymers. *J Forensic Sci* 2016, 61, Supp 1: S92-101
 5. ASTM E2288-09. Standard Guide for Physical Match of Paper Cuts, Tears, and Perforations in Forensic Document Examinations (Withdrawn 2018)
 6. Van Hoven, H.A. and H. D. Fraysier, "The Matching of Automotive Paint Chips by Surface Striation Alignment", *Journal of Forensic Sciences*, Vol. 28, No. 2. 1983. pp. 463-67.
 7. Jose A., A Validation Study of Fracture Matching Metal Specimens Failed in Tension, *AFTE Journal*, vol. 37 (2), Spring 2005, pp. 142-149
 8. TsadokTsach, SarenaWiesner, Yaron Shor, Empirical proof of physical match: Systematic research with tensile machine *Forensic Science International* Volume 166, Issue 1, 14 February 2007, Pages 77-83
 9. Christensen AM, Sylvester AD., Physical Matches of Bone, Shell and Tooth Fragments: A Validation Study. *J Forensic Science* 2008;53:694-698 Claytor & Davis, Validation of Fracture Matching Through the Microscopic Examination of the fractured Surfaces of Hacksaw Blades, *AFTE Journal*, Vol. 42(4), Fall 2010, pp. 323-334
 10. Katterwe, Horst W., Fracture Matching and Repetitive Experiments: A Contribution of Validation, *AFTE Journal* vol. 37 (3), Summer 2005, pp. 229-241
 11. McKasson SC and Richards CA. *Speaking as an Expert: A Guide for the Identification Sciences from the Laboratory to the Courtroom*. Springfield, Illinois: Charles C Thomas, 1998. pp. 50-51, 124-144
 12. Von Bremen, U. G. and Blunt, L., "Physical Comparison of Plastic Garbage Bags and Sandwich Bags", *Journal of Forensic Sciences*, Vol. 28, No. 3, July, 1983, pp. 644-654.
 13. Zugibe, F and J. Costello. "The Jigsaw Puzzle Identification of a Hit and Run Automobile", *Journal of Forensic Sciences*, Vol. 31, No.1. 1986, pp. 329-32.
 14. ASTM C1256 Standard Practice for Interpreting Fracture
 15. Quinn, GD. *Fractography of ceramics and glasses*. NIST Special Publication, 960-26e2, May 2016.
 16. Frechette, VD. *Failure analysis of brittle materials*. Advances in Ceramics, vol 28, The American Ceramic Society, Westerville, Ohio, 1990.
 17. Yekuteli, Y. Shor, Y, Wiesner, S, Tsach, T. *Physical Matching Verification*. US Department of Justice Report TP-2558. NCJRS

3a. In what ways would the research results improve current laboratory capabilities?

To date, there are no standard methodologies and criteria for making decisions about the presence of a physical fit and the significance of such evidence. Therefore, it is anticipated that validation studies to determine the quality and quantity of physical fit features will assist with the development of standardized methods and offer scientific support for the interpretation of the evidence.

3b. In what ways would the research results improve understanding of the scientific basis for the subcommittee(s)?

At the subcommittee level, these types of research would provide valuable support to the interpretation and report writing guidelines that are being developed for trace materials, particularly if we can integrate early in the process the feedback from practitioners, statisticians, the legal community and human resource experts. This research will also help different stakeholders within the OSAC to assess the utility and validity of these type examinations.

3c. In what ways would the research results improve services to the criminal justice system?

The data derived from the research will provide a better understanding of the validity and error rates of physical fit determinations during the comparison of trace materials. Given the anticipated probative value of such examinations and the role that the evidence can play during investigative stages and during trials, it is of utmost relevance to narrow current gaps of knowledge in this field.

4. Status assessment (I, II, III, or IV):

	Major gap in current knowledge	Minor gap in current knowledge
No or limited current research is being conducted	I	III
Existing current research is being conducted	II	IV

This research need has been identified by one or more subcommittees of OSAC and is being provided as an informational resource to the community.

Approvals:

Subcommittee

Approval date:

(Approval is by majority vote of subcommittee. Once approved, forward to SAC.)

SAC

1. Does the SAC agree with the research need? Yes No

2. Does the SAC agree with the status assessment? Yes No

If no, what is the status assessment of the SAC:

Approval date:

(Approval is by majority vote of SAC. Once approved, forward to NIST for posting.)