The Statistical Evaluation of a Torn Duct Tape Physical Matches

Frederic A. Tulleners, MA, Forensic Science Program, University of California-Davis, 1333 Research Park Drive, Davis, CA 95618. Jerome Braun, PhD, Statistics - Mathematics Department, University of California-Davis, One Shields Av. Drive, Davis, CA 95616*

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Duct Tape Usage

- Duct tapes are often submitted to crime laboratories as evidence associated with abductions, homicides, or construction of explosive devices.
- Analysts are often asked to analyze and compare commercial duct tapes to establish a possible evidentiary link between a suspect and a victim, or a suspect and a particular crime.
- Duct tape end matches, which is the association of two or more separated fragments, have a significant higher evidentiary value and are considered to be the one of strongest association in forensic science comparative examination.

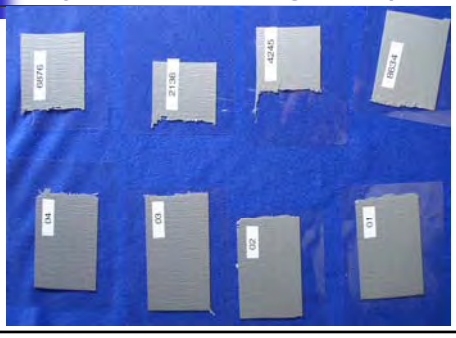
What is a Physical Match

- There is a lack of sufficient statistical data and objective criteria to support what constitutes a physical match.
- The typical statement from a crime laboratory report is that the specimens in question physically match.
- This statement assumes an absolute association without the consideration of any statistical data or error rates.
- Very little has been published in the area of tape or duct tape
- The most relevant is Bradley's article on duct tape:
- "Validation Study for Duct Tape End Matches" in J Forensic Sci, May 2006, Vol. 51, No. 3

Prior UC Davis Studies

- Prior studies conducted at UC Davis for a MS Thesis involved a series of torn duct tapes samples
- Study was presented at the February 2010 AAFS meeting under abstract A-197.
- 100 torn samples required comparison of all torn samples to all the matching exemplars
- The set included 6 random non-matching specimens
- Anther experiment 25 uniform Elmendorf tear samples were made
- Results:
  - Two analysts correctly identified all 100 torn duct tape samples = ~ 10,000 comparisons
  - Two analysts correctly identified all 52 Elmendorf tear samples = ~ 625 comparisons

Physical Matching – Tapes



Experimental Objective

- Obtain statistics on the end matching of duct tape samples, not only the success rate but also their failure rate
- Determine the error rate of end match analysis
- Compare multiple torn duct tape samples using several graduate student researchers (GSR's)
- Look at tape variety by using different types of duct tapes
- The GSRs' needed extensive training in order to be credible analysts
- Developed a 150-200 hour competency program for the training of the GSRs'
- Can we develop "match" criteria?

G.S. Researcher Training Validation

- Extensive literature review of all available tape articles
- Began with 25 duct tape tears requiring comparisons to all four torn ends
- The next two series of tape samples were considered validation/proficiency samples
- Compared 100 torn samples previously described
- Compared the Elmendorf samples
- Results no errors in the two test sets
- Minor clerical error by one student during the first time he worked with a duct tape training sample. Did fine during the validation series

Experimental Methodology

- The "Rule of 3" is a simple relationship that describes a 95% confidence limit for the rate of a rare event, given that no events were observed. If n is the sample size, then $3/n$ gives the upper 95% confidence limit of the rate of the rare event.
- Example 1: To detect a rate of 1/1000 with 95% confidence requires that n = 3000.
- Example 2: A sample size of 1000 will allow detection of a rate of 3/1000 with 95% confidence.
- Example 3: A sample size of 100 will allow a detection of a rate of 3/100 with 95% confidence
- We will assess both false positive rates and false negative rates.

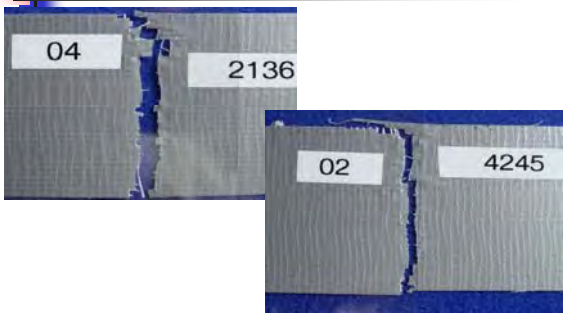
Experimental Methodology

- The design should produce information that will be relevant to the real world situation. This will typically be:
- One exemplar piece of duct tape taken from the end of the roll of duct tape;
- One or more evidential pieces of duct tape to be matched against the exemplar.
- The design should be blinded. That is, the person who constructs the sample pairs should not participate in the actual identification process as an analyst
- Two manufacturers will be assessed (Scotch and 3M, the top two manufacturers) along with two colors from each (silver and black) and two duct tape grades.

Experimental Methodology

- 200 envelopes will be constructed. Half of the envelopes will contain matches; half of the envelopes will contain non-matches. With eight combinations, and 200 pairs of duct tape pieces per combination, a total of 1,600 pairs will be assigned to envelopes. The contents of the envelopes will be completely randomized across all 1,600 pairs.
- Three analysts will be assessed. The envelopes will be analyzed in the order of the envelope identifiers (from 1 to 1,600). Each analyst will encounter the same sequence of samples to avoid differential learning effects. This will yield a total of 1,600 assessments per analyst.

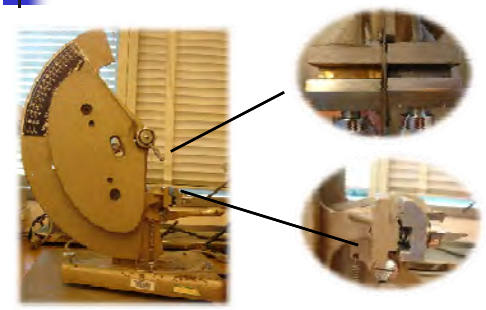
Typical Sample of Duct Tape



Statistical Analysis

- The primary summary will be the overall false positive rate and false negative rate for each analyst, along with the 95% confidence limits for the rates.
- The next level of summary will be false positive and false negative rates by analyst and across all combinations of factors that were varied. This will include marginal rates for each factor that was varied.
- Statistical analyses will be performed using SAS for Windows, Version 9.2 or greater (2002-2008, SAS Institute Inc., Cary, NC).

Elmendorf Tear Testing



Elmendorf Testing Issues

- A typical Elmendorf Tear sample is initiated by a razor blade
- We will tear 200 samples of one particular tape brand
- The tear tester will measure the tensile factors in pounds as the tape is torn
- This will be a more challenging test . While the tear can be identified as having been initiated by a razor blade , the actual tear patterns are very uniform

Current Status

- Data collection on going
- Expect to have all the tapes torn tape samples analyzed by August 1, 2001
- August - September Elmendorf tear testing (200 specimens)
- Further testing as time permits
  - Time permitting, cut samples end match comparison
- PROJECT GSRs'
- *Ka Lok Chan, Kaitlin McGabe, Gillian Currie and Esmeraldo Gorecho*