The Synergistic Nature of Trace Evidence and Tool Mark Examinations

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Abstract

The use and application of a variety of tools is commonplace during the commission of various criminal acts. By their very nature, the use of tools typically involves the application of relatively large amounts of force to gain a mechanical advantage in performing a work related task. In accordance with Locard's Exchange Principle, the application of force often results in the transfer of significant amounts of trace evidence from the surface of the substrate to the surfaces of the tool and vice versa. The transferred trace evidence that is encountered often consists of paints/coatings, metal flakes and fragments, glass particles, wood, fibers, and various resins and polymers.

It should come as no surprise that the trace evidence recovered from tools and their worked surfaces can be utilized to provide valuable corroborative and investigative evidence. Such evidence would be especially valuable in situations where tool marks do not contain sufficient information for comparison, or the information that is present only yields class characteristics without sufficient individual detail.

The purpose of this presentation is to discuss the important role that trace evidence plays during the examination of tool mark related evidence. In order to illustrate the significance of the relationship between trace evidence and tool marks, various case related studies will be discussed.

Introduction

The value of trace evidence when utilized in conjunction with firearms and tool mark related evidence has been previously documented by various groups (1-6). While discussed in numerous texts (7-10), and widely applied in the laboratory, it has been the experience of the authors that many attorney's and various members of the investigative arm of law enforcement are not aware of the potential that trace evidence holds when it is analyzed in conjunction with tool mark evidence.

On their own, both tool marks and trace evidence can be a valuable source of information when investigating criminal activities. They can both be utilized to provide links between suspects, scenes, and victims, as well as to provide valuable investigative leads. If marks of high quality are present and a tool is recovered in a timely fashion, tool mark evidence can be utilized to provide a definitive link between a suspect tool and a questioned mark. Trace evidence is most typically utilized to provide circumstantial evidence. The strength of trace evidence is greatly increased when numerous associations are made between questioned items and known items. Simply put, the more trace evidence that is found, identified, and compared, the stronger the evidence becomes. A key factor in the strength of trace evidence is the occurrence of a cross transfer which occurs when evidence from one surface is transferred to another, while evidence from the second surface is also transferred to the original item. A good example of a cross transfer would involve a situation where an individual gains access to a structure through a broken window. While climbing through the window, broken glass is transferred to the suspect's clothes while fibers from the suspect's clothes are transferred to the broken glass at the windows edge.

Any discussion of forensic science would not be complete without the mention of Locard's exchange principle. In a reduced sense, this principle states that any time two items come into contact with one another there is a mutual exchange of matter from one item to the other in at least some minute fashion (11). In accordance with this principle, substantial transfers become more likely when a significant amount of force is applied. It should be noted that this type of relationship governs the fields of both tool mark and trace evidence analysis, where such transfers form the basis for making connections between evidentiary sources.

Discussion

Tool Marks

Tool marks are typically impressed or striated markings that a hard object (the tool) leaves on a relatively softer surface. The broad definition of a tool as "an object used to gain a mechanical advantage" (12) results in just about any object having the potential to become a tool. As such, a large variety of tools may be encountered during the commission of criminal acts with an even larger variety of potential surfaces for marks to be impressed or striated upon. Throughout the forensic field, it is well known that tool marks are a valuable source of evidence. It is not uncommon to recover a tool related to scenes of forced entry, burglary, or violent interactions. Some of the more common types of tools include, but certainly are not limited to: bolt cutters, screwdrivers, pry bars, drill bits, knives, and hammers. The use of many such objects typically requires the application of a substantial amount of force, which often results in a transfer of material from the tool to the worked surface and vice versa.

Trace Evidence

Trace evidence is a very broad term that has come to encompass a wide variety of materials. Some of the more common types of trace evidence that are routinely encountered include: paint, glass, soil, hairs, and fibers. Additionally, various other microscopic (and not so microscopic) items have been very useful as well, including: pollen, feathers, polymers, building materials (metals, gypsum, concrete/brick, wood, insulation etc.), adhesives, etc. This list can go on ad nauseam. The basic premise is that anything in the physical environment has the potential to become a relevant form of trace evidence.

The recognition of trace evidence can be a challenge. In some situations, transfer evidence that is present may be completely obvious (e.g. large visible paint smears on a pry bar). However, in other cases, the trace evidence that is present may live up to its name and be present in "trace" amounts. In such situations, it would be advantageous to have someone who is well trained in the examination of trace evidence look at the evidence in question. It should be noted that the recognition of trace evidence often requires the use of various types of microscopy and objects at the microscopic level can look quite different than they do to the untrained naked eye. Through training and experience, trace evidence analysts are well suited for the recognition of potentially useful transfer evidence on the surfaces of tools.

Complementary Nature of Trace Evidence and Tool Mark Examinations

Although the potential for making definitive links using tool marks exists, it is not always the case. For various reasons a questioned marking might not compare to test marks made with a known tool. Some of these reasons are obvious, such as the known tool not being the tool that made the mark, allowing it to be immediately ruled out based on class characteristics. Other situations may present more of a challenge, for instance, when the surface is not receptive to high quality markings, when there is a substantial amount of oxidation, or when there is an organic or inorganic coating that reduces the quality of any potential marks. If, for example, the class characteristics compare and insufficient individual detail is present, it would not be possible to make any conclusive determinations. In such a circumstance, it would be advantageous if trace evidence were available to help associate the two items in question.

Importance of Proper Handling and Communication

The analysis and comparison of trace evidence requires the proper recognition, documentation, and collection of any evidence that may be present. The recognition of trace evidence often requires specialized equipment in conjunction with a great deal of experience. As previously stated, microscopic evidence often looks vastly different than its macroscopic counterpart. Therefore, the individuals most suited for these tasks are the trace evidence examiners themselves.

The laboratory of the authors presents a relatively unique situation where the trace evidence examiner also performs the tool mark examination. Although this works in our

laboratory, it is recognized that this set-up may not be feasible in other laboratories. Some alternate ideal situations where any possible trace evidence could be recovered in a suitable manner would be: 1) the trace evidence examiner receives the evidence prior to any tool mark examinations, 2) the trace evidence examiner performs the recognition, documentation, and collection steps in conjunction with the tool mark examiner, or 3) the tool mark examiner is properly trained in the recognition, documentation, and collection of trace evidence. Additionally, it should be stressed that the tool mark and trace evidence examiners must have a good line of communication to discuss the particulars of the case.

Case Studies

In order to illustrate the potential for trace evidence when performing tool mark examinations, we will discuss several case examples below. These cases were chosen to provide various examples of the different types of trace evidence that may be encountered and how such evidence can be utilized to provide substantial information.

Case #1 (Trace Evidence in Support of a Positive Tool Mark Identification)

This instance involved a burglary where a safe in a commercial establishment was forcibly entered. In conjunction with this case, an open safe was submitted along with a suspect pry bar. Visual examination of the safe revealed numerous marks characteristic of forcible entry with a pry bar type tool. Visual examination of the safe interior disclosed a pile of debris underneath a shelf that had fallen to the bottom. Within this

debris, remnants of a barcode were discovered (see Figure 1). Examination of the pry bar revealed remnants of a barcode along the shaft (Figure 2). A physical fit was performed and the barcode in the safe was observed to physically fit into the missing portions of bar code on the pry bar. Although a positive identification was made via tool mark comparison, the bar code physical match provided additional support that would be easier to convey to a jury.

Figure 1. Portions of barcode recovered from safe.

Figure 2. Bar code remnants on suspect pry bar.

Case #2 (Trace Evidence in Support of a Tool Mark Inconclusive)

This case involved a typical burglary where a lock hasp u-bolt was cut using bolt cutters. Prior to performing any tool mark comparisons, the bolt cutter was visually and stereomicroscopically examined for the presence of any trace evidence.

Stereomicroscopic examination of the tip of the bolt cutter revealed the presence of a minute green paint particle (Figure 3). Examination of the u-bolt assembly using the same means revealed the presence of various layers of green paint (Figure 4).

Prior to analyzing the paint, a tool mark comparison was performed. The questioned marks showed the same class characteristics as test marks made with the bolt cutter; however, insufficient individual detail was present to make any conclusive connections between the two.

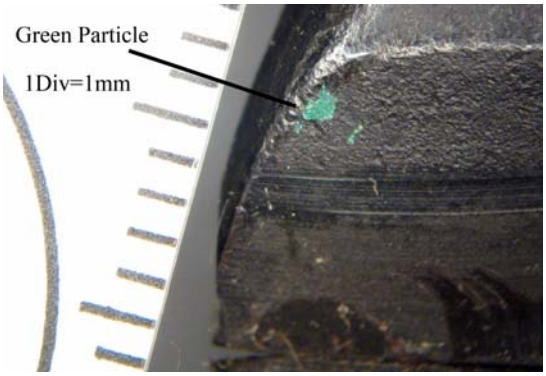

Figure 3. Green paint on suspect bolt cutter.

Figure 4.Green paint on u-bolt assembly.

Chemical analysis and comparison of the green paint revealed that the green paint removed from the u-bolt assembly could not be excluded as the source of the green paint particle recovered from the bolt cutter. Although it did not provide a tremendous amount of information, the paint comparison, in conjunction with the class characteristics in the tool mark, were sufficient to provide a better link between the questioned tool and the scene.

Case #3 (Trace Evidence in Support of a Tool Mark in the Absence of DNA Evidence)

This case involved a breaking and entering that led to an attempted sexual assault. During the commission of the crime, it was believed that the perpetrator used a knife to open a door at the victim's residence. The same knife was reportedly held to the neck of the victim causing some superficial cuts with little to no bleeding. A suspect was quickly apprehended with a knife in his possession, which matched the description given by the victim.

Initial analysis of the knife focused on the recovery of biological evidence in order to pursue DNA analysis. The prosecution had hoped that enough blood and/or epithelial cells had been transferred to the blade to produce a biological link between the knife and the victim. During the initial processing of the knife, it was swabbed for biological collection with no stereomicroscopic examination for the presence of any trace evidence. Analysis of the swabs failed to produce any significant DNA related information.

As an afterthought, the knife was submitted for tool mark and trace evidence analysis. In addition to the knife, two locksets and strike plates from two different doors at the scene were submitted for analysis. Visual and stereomicroscopic examination of the knife revealed the presence of several fresh scratch marks near the tip of the blade. The scratch marks were observed to be present on both sides of the blade in the same general locations. In the same vicinity as the scratch marks, several minute white paint smears were observed and subsequently recovered (see Figure 5).

Visual and stereomicroscopic examination of the locksets and strike plates revealed that they were both painted over with white paint. Further examination of the first lockset and accompanying strike plate did not reveal any suspect marks. However, several suspect marks were observed on the second lockset and its accompanying strike plate. These marks consisted of fresh, sharp cuts into the paint on the strike plate (see Figure 6) as well several sharp linear marks cut across the latch bolt (see Figure 7).

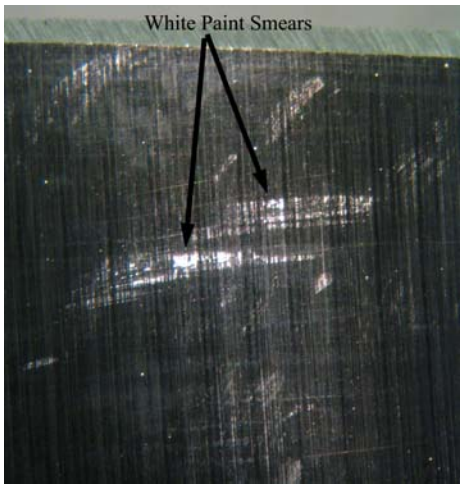

Figure 5. White paint smears on suspect knife blade.

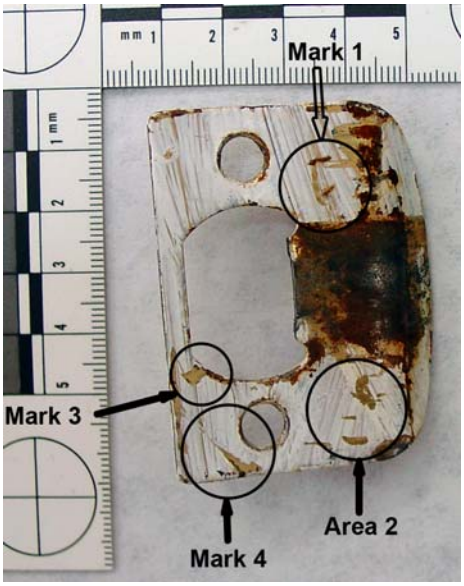

Figure 6. Marks on strike plate from scene.

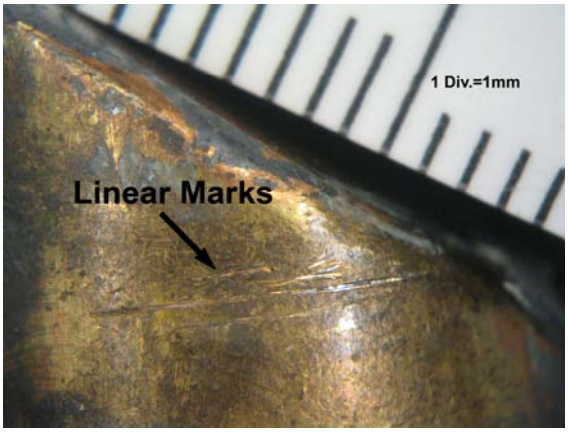

Figure 7. Linear marks on latch bolt from scene.

Test cuts made with the knife produced marks with the same class characteristics as those present on the second lockset. This comparison was only used to attempt an exclusion based on class characteristics, as any sharp blade could be used to produce

similar marks. Therefore, this comparison did not provide any substantial connection between the knife and the questioned marks.

Up to this point, the only facts that could be established were: 1) there were marks characteristic of forced entry on the second lockset and the suspect knife could not be ruled out as having made the questioned marks, and 2) the presence of the scratches on the knife blade were consistent with the knife having been used in a similar fashion. However, there was no significant physical link.

Chemical analysis of the white paint smear was then pursued and the white smears on the blade were found to be chemically comparable to the white paint observed on the second lockset.

Based on the tool marks and trace evidence, the investigators were able to determine where the point of entry was at the victim's residence and circumstantially link the suspect's knife to the scene. When the investigators confronted the suspect with a reconstruction of the event that was heavily based on the results of the tool mark and trace evidence analyses, the suspect immediately took a plea deal.

Case #4 (Cross Transfer in Conjunction with Class Characteristics)

The final case to be discussed involved a breaking and entering where a sledgehammer was used to gain access to a safe. The safe door and a sledgehammer found in possession of the suspect were submitted for analysis. Visual examination of the safe door revealed the presence of numerous circular and semi-circular indentations. Detailed examination of the indentations revealed the presence of concentric circles that

were imparted into the safe coating as well as into its metal substrate. In various locations on the door, missing areas of black and white coating were observed in conjunction with the marks on the door. Additionally, several smears of what appeared to be yellow and red-brown paint were observed on top of the outer black safe coating in the indentations (see Figures 8 and 9).

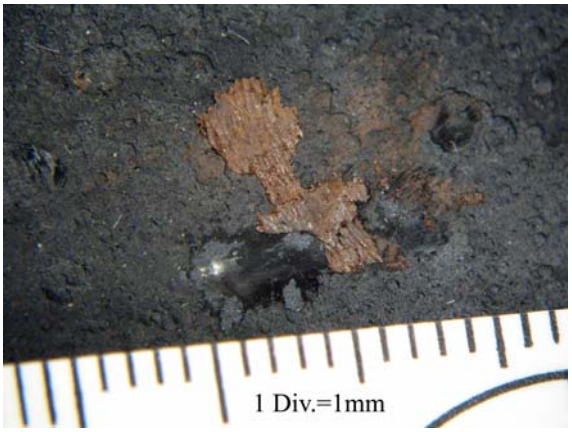

Figure 8. Red-brown paint observed on the safe door.

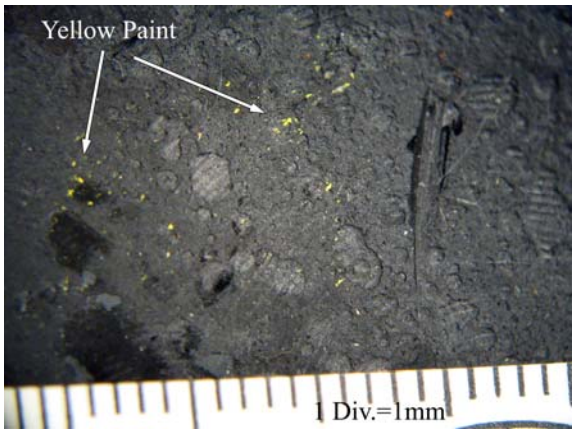

Figure 9. Yellow paint observed on safe door.

Examination of the striking surfaces of the sledgehammer revealed a pattern of concentric circles similar to those observed in the indentations on the safe. Comparison

of the striking surfaces to the indentations safe provided a class correspondence between the concentric circular pattern on the striking surfaces and the patterns observed in the questioned indentations. The same curvature, diameter, and spacing were observed. Upon further analysis, insufficient individual detail was present to make any definitive tool mark related conclusions.

Figure 10. Paint observed on the sledgehammer.

Figure 11. Black and white paint on sledgehammer.

In addition to the facial characteristics of the striking surfaces, black, white, yellow, and red-brown paint smears were also observed (see Figures 10 and 11). Comparison of the various paint smears observed on the sledgehammer and the smears and coating on the safe door revealed that all of the paint samples were chemically comparable.

Based on these results, it was determined that a cross transfer had occurred where the black and white coatings from the safe were transferred to the sledgehammer and the yellow and red-brown paint from the sledgehammer was transferred to the safe. In this instance the combination of the class characteristics and the cross transfers of the paint provided very strong evidence that the suspect tool had been in contact with the safe door.

Conclusion

It has been the experience of the authors that trace evidence is often encountered during the examination of tool mark evidence. Often, there are cross transfers of such evidence between the tool and the marked surface. When properly documented, collected, and compared, trace evidence can provide valuable evidence to support a connection between a suspect tool and a questioned mark. In the case of a tool mark identification, the transfer of trace evidence can be used to provide additional support for contact as well as investigative information. In the case of an inconclusive tool mark examination, the comparison of any trace evidence transfers may provide additional information to support a connection. The strength of such a connection can be enhanced

through the comparison of unusual types of matter, cross transfers, multiple transfers, or a combination of any of the above.

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