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Illustration and analysis of a coordinated approach to an effective forensic trace evidence capability

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ABSTRACT

An effective trace evidence capability is defined as one that exploits all useful particle types, chooses appropriate technologies to do so, and directly integrates the findings with case-specific problems. Limitations of current approaches inhibit the attainment of an effective capability and it has been strongly argued that a new approach to trace evidence analysis is essential.

A hypothetical case example is presented to illustrate and analyze how forensic particle analysis can be used as a powerful practical tool in forensic investigations. The specifics in this example, including the casework investigation, laboratory analyses, and close professional interactions, provide focal points for subsequent analysis of how this outcome can be achieved. This leads to the specification of five key elements that are deemed necessary and sufficient for effective forensic particle analysis: (1) a dynamic forensic analytical approach, (2) concise and efficient protocols addressing particle combinations, (3) multidisciplinary capabilities of analysis and interpretation, (4) readily accessible external specialist resources, and (5) information integration and communication.

A coordinating role, absent in current approaches to trace evidence analysis, is essential to achieving these elements. However, the level of expertise required for the coordinating role is readily attainable. Some additional laboratory protocols are also essential. However, none of these has greater staffing requirements than those routinely met by existing forensic trace evidence practitioners. The major challenges that remain are organizational acceptance, planning and implementation.

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1. Introduction

This paper illustrates and analyzes how forensic particle analysis, appropriately applied, can result in an effective trace evidence capability. The limitations associated with current approaches have been detailed in [1], with the summary findings that (1) there are complex and challenging problems facing the effective utilization of trace evidence, and (2) these problems are exacerbated, rather than addressed as new technologies are being incorporated into forensic laboratories and as the profession responds to pressures from the legal and broader scientific communities. The overall conclusion was that a new approach is necessary to achieve an effective trace evidence capability. This paper presents an illustration of this new approach.

Beginning with conclusions as argued and expressed in [1], we accept (as a starting point for this paper) the hallmarks of an effective trace evidence capability to be:

1. Particle traces should be a major problem-solving tool.
2. There should be readily available, straightforward methods to enable their use.
3. All available and potentially useful particle types should be considered.
4. Decisions to use them should be made in the context of each case, guided by what they can contribute to the case and how efficiently they can do so.
5. Analyses should be conducted using appropriate technologies.
6. Findings should be timely and directly integrated with case-specific problems.
7. New technologies should be used to improve the overall effectiveness of the capability.

This paper begins with a hypothetical case example illustrating a broader vision of how forensic particle analysis ought to be used.

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The specifics in this example provide focal points for subsequent analysis of how this outcome can be achieved. This leads to the specification of key elements that are deemed necessary and sufficient for effective forensic particle analysis. The paper concludes with an analysis of the benefits and limitations of trace evidence analysis when these key elements are employed.

The case example illustrates an effective trace evidence capability, meeting the seven hallmarks above. Although much of the investigative and laboratory work follows what we consider to be prevailing forensic trace evidence practices and capabilities, three aspects are substantially different.

Firstly, there are four professional roles in this case example. Three of these are familiar ones: the case investigator, the crime laboratory trace evidence practitioners, and specialists (or laboratories) with expertise in the analysis or occurrence of specific materials. The fourth role is new: the *particle role* (PR). As will be seen, this role is primarily an investigative one, focused on the integration of case specifics with the laboratory findings. Information provided by the PR leads the case investigator to strategic decisions such as which specimens to analyze, and in what way, to address investigative needs.

The second of the three differences is that the trace evidence practitioners have a number of additional analytical protocols that apply to combinations of many particles. These protocols are very focused in their scope, so as to be timely and efficient. The protocols include, for example, the recovery of small particles (of all types) from different areas of an item, and the general characterization of particle combinations: what different types are represented in a mixed specimen, and in what proportions.

The third difference to note in the case example is that the case investigator is knowledgeable regarding the potential contributions of small particles to the investigation, including the types of evidence collections and associated investigative steps that enable this contribution.

2. A case example

The following hypothetical criminal investigation case example was designed to illustrate an effective trace evidence analysis capability. Unlike the work of Schuliar [2], whose proposed role of a forensic coordinator is based explicitly on the study of a comprehensive set of actual cases, our case is synthetic – a construct fitted to our view of how an effective trace evidence capability should perform and employed in this manuscript to illustrate this view.

Forensic investigation is, of course, not limited to criminal matters; it is also applied in private industry, in the military, in support of national security, and in the intelligence communities. Criminal investigation was chosen as a common application, of which most readers would be familiar.

Although any example brings with it a set of specifics that cannot be generally applied, we have included investigative questions, types of evidence, and circumstances that commonly occur. The analytical methods that are employed use existing technologies. Some are advanced, but all are practical and can be readily implemented; they are not esoteric, expensive or even cutting-edge.

As a last introductory point, we note that this case example is not meant to show all the ways that particle analysis could contribute to forensic casework. Rather, it shows how particle analysis can make a significant contribution when it is used strategically and closely integrated with other investigative methods.

2.1. The crime, initial investigative steps, laboratory analysis and contribution

2.1.1. Crime scene circumstances and collections

A single woman has been found dead in her apartment, fully clothed, lying face down on her carpet with a military-style knife in her back. It has been some time since death (a day or so). There is no sign of forced entry and the front door is unlocked. Collections from the scene include latent prints, the body with its associated clothing, bloodstains found on the carpet, and control samples. At autopsy, evidence collections include the knife, victim's clothing (shirt, trousers, underclothing, shoes, socks), fingernail scrapings, particle specimens from the victim's hair, and reference samples of her hair and blood.

2.1.2. Initial investigative information

Initial investigations reveal that the victim had a steady boyfriend and there was no indication of trouble in the relationship. The boyfriend states that they had a date to go out, but that she canceled and said she was staying home that evening. He then went out with friends. This statement is supported by his friends and by telephone records, but the timing of his alibi does not rule him out as a suspect. He is not known to have had a military-style knife.

The medical examiner concludes the manner of death as homicide and the knife wound as the cause of death. The victim died sometime the evening before her body was discovered. There are low levels of alcohol in her blood.

2.1.3. Initial investigative questions and actions

The case investigator's (CI's) initial questions focus on evaluation of the boyfriend as a suspect and determining whether the victim left her apartment on the evening of her death. Based on an understanding of the full range of potential contributions from forensic laboratory analyses (including particle analysis), the CI assesses the available physical collections and the ability of laboratory work to address these questions.

Attribution of the knife is clearly of central importance. Specimens available on the knife are any latent prints (which may be present), any DNA traces (which may be present), and any adhering particles (which are always present). The CI decides to submit the knife to the laboratory for (1) recovery and analysis of any latent prints, (2) recovery and analysis of any DNA traces, and (3) recovery and an assessment examination of the particles. He also submits the victim's blood (for comparison to any DNA found on the knife). The CI obtains finger prints, palm prints, and cheek swabs from the boyfriend. He is cooperative.

Whether or not the victim went out is also of central importance, as it reflects on the veracity of the boyfriend's statement and could materially affect the focus the investigation. Specimens available to check for recent outdoor exposures are particles from the victim's head hair and particles adhering to her lower pant legs and her upper socks. The CI decides to submit the victim's pants, socks and head hair specimens to the laboratory for assessment of recent outdoor exposure.

2.1.4. Laboratory findings for the knife

No useful latent prints are found on the knife and there are no traces of DNA other than those attributable to the victim's blood. For the laboratory's particle findings, the CI meets with the PR. The PR is a new position on the investigative team. Details of this position, its function, why it is necessary, and the required qualifications are discussed in detail at the end of this case example. Here, the PR's job is to present the laboratory findings, discuss their significance within the context of the ongoing investigation, and provide input on the choice of any appropriate

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