Article

Is Forensic Science Worth It?[1]

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Abstract The usefulness of forensic science continues to be questioned by evaluative studies taking as indicator its judicial contribution, mainly resulting in disastrous conclusions. The used indicators highly underrate and limit the actual contribution of forensic science, which are dependent on the definition, object, role, and integration in the criminal justice process accorded to the discipline. When considering the utility of the clue, different dimensions can be differentiated, within the investigation and beyond. Through a qualitative analysis of robbery cases, utility dimensions such as the identification of suspects (not solely confirmation of already known suspects), the reconstruction of the microsequence of events, the determination of the implication of suspects, could be highlighted, thus drawing a more diverse and complete picture of the value of forensic science.

Introduction

As frustrating as it may seem, the answer to the question 'Is forensic science worth it?' has to be: It depends. The outcome of the assessment of the contribution of forensic science is not straightforward; it is shaped by underlying conceptual perceptions and definitions such as the definition of forensic science itself, its object, the role and integration of forensic science in the criminal justice process (encompassing divergence in the delineations of what pertains to this process), the indicators used to measure the contribution, and the impact scope granted to forensic science (in line with its definition and role). The influence of these elements is of utmost importance, but more often than not, this is not considered nor clarified when the value of forensic science is discussed. Measuring the value of forensic science more appropriately than has been done in the past could is yet a major issue as it assists law enforcement managers in allocating resources more effectively and efficiently, potentially contributing to better policing outcomes (e.g. case clearance rates). A recent illustration refers to the discussion which follows the publication of the US President's Council of Advisors on Science and Technology (PCAST, 2016) report on the scientific validity of pattern comparison methods in forensic science. This report questioned the scientific validity of seven

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forensic science practices, challenging the admissibility of evidence proposed by some of them in the court of law. While this report provoked many reactions and criticisms, very few—not to say none—highlighted the fact that this evaluation pertaining to the contribution of forensic science was only concerned with the production of evidence for court, totally neglecting the significant, even essential, contribution that these practices provide for investigation and security issues. Most of the recent evaluative studies focus solely on this finality (Peterson *et al.*, 2013), reaching alarming findings regarding the usefulness of forensic examination. For instance, when considering the contribution to identification, forensic science was attributed a determining role in a mere 2% of homicide cases (Brodeur, 2005). This is only one single example, but other relevant literature is discussed in a later section.

In the scope of this article, the focus will mainly be set on the measurement of the contribution of forensic science to the investigation, through the prism of a key indicator—the utility of clues. However, it must be noted that for completeness' sake, the impact of forensic science in a general security context (for instance for crime detection, crime prevention, crime mitigation, etc.) should definitely be taken into account when assessing its real value and usefulness (Delémont et al., 2017).

Definition and integration model of forensic science

The commonly understood role of forensic science views it as and limits it to a body of scientific techniques applied to matters of the court ('forensics' versus forensic science, see Roux *et al.*, 2012). In this understanding, forensic science is denied the core foundations of a scientific discipline on its own, as symptomatically emphasized in the 2009 NAS report (National Research Council, 2009), and its impact scope is restricted to a very particular point, oriented towards issues of the court. Accordingly, its quality standards focus on technological advancements and their related validation procedures, instead of the value of the information inferred from the traces detected in the investigation process.

The definition of forensic science goes hand in hand with its integration in the criminal justice process, with the way in which forensic scientists communicate, collaborate, and reason together with other stakeholders (police investigators, crime analysts, prosecutors, judges, etc.) in a common context and on a common objet, crime. In order to achieve this fully integrated model, forensic science needs to be considered and recognized on its own, with its own reasoning scheme and inherent decision-making processes, and as holding the potential to provide a useful contribution at different levels, and for several dimensions (Margot, 2011; Roux *et al.*, 2012; Ribaux *et al.*, 2015; Bitzer *et al.*, 2016). In this perspective, the different levels constitute the diverse contexts to which forensic science can contribute, in the form of intelligence, investigative leads or evidence, i.e. the different steps of the criminal justice process or the general security context. While the place of forensic science within the prosecution and judgment processes has been largely discussed in the past, its role in a wider security context has attracted less attention. Thus, forensic science does provide actionable knowledge that may reveal repetitive offenses by prolific offenders (based on recurring trace patterns), decipher criminal trends (through information about modus operandi that are conveyed by traces), and support the implementation of preventive measures (Rossy *et al.*, 2013). This can be described as utility dimensions provided by forensic science, dimensions that offer different information facets contributing to specific levels in understanding crimes. For instance, in the perspective of the criminal justice process, utility dimensions are for instance suspect identification, confirmation of a known suspect's involvement, or linking crimes.

The basis for a holistic assessment of its contribution lies in a definition of forensic science that ignores—or overcomes—restrictive logics in which some users would like to enmesh it. We therefore acknowledge the pivotal role of the trace as the central and fundamental object of forensic science. The trace is vestige, often invisible, witness of past events. It is considered a vector of information (Margot, 2011, 2014), bearing information regarding these past events, which is not directly accessible but needs to be deciphered and inferred. When the user can infer a link between the trace and a case under scrutiny (or a question in this case), this trace is considered relevant to that user. The information conveyed by the trace—the clue—needs to be understood by the user, who assesses the entities and the link between these two within the case circumstances. A useful clue constitutes information adding value to the case beyond what is already known, and is given the status of intelligence. This general intelligence framework takes into account all the information contributing to the knowledge base and it is evaluated as it supplements the information previously available to the user. In this way, the utility of the clue depends on the inherent information potential of the trace, but also on the information already available to the user. A confirmation of an already determined information is in general not as useful as the identification of a previously unknown person involved in the case. While on another level, this confirmation may also be useful for the reconstruction of the sequence of events performed by this same person. It is through the assessment of this usefulness that one can determine the actual contribution of forensic science to the criminal justice process (Bitzer *et al.*, 2015), which will be outlined later in this article.

Decision-making process

Formalizations of the criminal investigation process have been suggested decomposing the investigation in different phases—or chapters—on the basis of their underlying reasoning processes (from induction to hypothetical-deductive and abduction (Kwan, 1977)). In his three-chapter paradigm, Stuart Kind (1994) distinguished (1) the first phase of the investigation, merely focusing on the problem to find and arrest the perpetrator; (2) the refinement, checking, reconstruction of events, as well as the preparation for trial; and finally (3) the criminal trial (the problem to prove). In a similar—yet slightly different—formalization, Jean-Paul Brodeur (2005) differentiates three steps, with a focus on the investigative phase: the identification of the suspect, the localization of the suspect, and the structuring of the evidence. Both fail to describe the essential data collection phase obtained from crime scenes and take for granted what is brought to the scientist for analysis.

Focusing more specifically on crime scene examination, we suggest a complementary model that is not articulated around reasoning schemes, but founded on the decision-making process underlying this examination. This is structured by seven embedded milestones: (a) the decision to attend a crime scene, (b) the decision to proceed to the search for traces, (c) the decision to collect detected traces, (d) the decision to analyse them, (e) to use them in the investigation, and/or (f) use them in an intelligence perspective, and, finally, (g) the decision to use them for court purposes (Bitzer *et al.*, 2015, 2016). This splitting up in successive decision-making steps emphasizes the crucial importance of crime scene processing and the multiple skills it entails. After all, the detection, recognition, and collection of traces by crime scene investigators with a thorough forensic science culture constitute the basis for all further forensic processes (including digital crime investigation). Crime scene investigation plays a major, however, often underrated role in the criminal justice process and within law enforcement organizations despite the fact that this is the major diagnostic step that will decide the value of all further scientific analyses. It (almost) always intervenes in the beginning of the investigation and initiates the inherent decision-

making and reasoning chain revolving around its vector of information. Missing relevant traces at this early step leads to a loss of information that may hinder or mislead the rest of the process.

This model of successive decision-making steps is inspired by the practice of forensic science in parts of Switzerland. It showcases an integration system of forensic science from the start of the investigation, and the accepted consideration of its potential use in a broader context, beyond the sole case-by-case approach, in an intelligence-based perspective. Indeed, forensic science generalists (5 years university-based training and education with a strong focus on detection and diagnosis) are deployed to the (majority of the) crime scene(s), putting a focus on the quality, pertinence, and utility of the collected traces. The same generalists, immersed in the context of the case, decide on which traces will be analysed or tested (either in-house or sent to an external laboratory) and for what purpose, in agreement with the person (a magistrate in Switzerland) in charge of the case. The consideration of the complete decision-making process emphasizes the need for it to be perceived as a whole, with the previous decision-making steps influencing the subsequent, but also the anticipation of the later guiding previous ones. Here, the importance of the crime scene investigation is recognized, as the founding stage of the investigation and of the process of information gathering from the trace. It is akin to a diagnostic phase in medicine. Based on observations of clues, the doctor will decide on tests that will help consolidate or disprove a diagnosis.

Empirical findings

An empirical study was developed that concentrated on the decision to analyse a trace. A study on the diversity of the utility of the clue was undertaken by considering robbery cases investigated by the forensic unit of a Swiss cantonal police during the 2012–2013 period ($N = 101$). Emphasis was put on collected biological traces (DNA) at the scenes or on recovered objects. The factors influencing the decision to analyse a trace were detailed and their influence determined. A total of 410 collected biological traces were considered; 74% of those were analysed. Notwithstanding the focus of this study on biological traces, other types of traces and their contribution were considered when it comes to assessing the overall value of forensic science. Taking into account that the ways in which forensic science resources are mobilized for serious and major crimes differ from its use in high-volume crimes, robbery cases were chosen as a compromise between homicide and burglary cases. Indeed, a comparison of the number of collected biological traces between these three types of offences revealed differing moments of triaging (see Bitzer, 2016). In high volume crimes, cost-effectiveness appears to play a role when choosing traces for analysis and the triaging step is anticipated to the previous decision step, the collection of traces (Wilson-Kovacs, 2014). Whereas in homicide cases, crime scene investigators tend to collect more widely, without much triaging taking place during the collection phase.

We analysed the most significant parameters that influence the decision to analyse a trace. The several considered factors were spread out in five knowledge dimensions: the first four suggested by Ribaux *et al.* (2010)—strategic, immediate, criminal, and physical environments—and the utility dimension. The strategic environment includes the seriousness of the case, the invested resources in time, material, and personnel, etc. The case circumstances, in terms of the situation and sequence of actions, constitute its immediate dimension. The knowledge of crime phenomena, and active series of linked cases, defines the criminal knowledge dimension. The type of trace, its perceived relevance and pertinence (also depending on the matrix it is collected from), as well as the knowledge pertaining to the technical procedure for its detection, enhancement, and collection correspond to the physical dimension. The utility dimension refers to the

conjecture of the utility that a trace might potentially have in the context of a case, taking into account the overall knowledge (such as other traces and information) already available at the time the decision is made.

The first outcome from this empirical study was that there was a discrepancy between existing managerial policies (whether formal or informal) and the reality of practice. The factors involved in the decision to analyse a trace are manifold (Bitzer *et al.*, 2016) as well as the underlying reasoning process. This is mirroring the complexity of the situation that crime scene examiners are faced with. Contributing factors include implicit actionable knowledge, such as shared experience of positive results obtained previously, so that traces may be chosen for analysis based on previously yielded results. Another factor, also mentioned in the literature (Ramsay, 1987; Horvath and Meesig, 1996), is the knowledge of a suspect identification in the case. However, contrary to the recurrent belief, this was a limiting factor for the analysis of traces (when a suspect is known, fewer traces are analysed), instead of supporting its use for confirmation purposes, whereas the identification potential, through the extraction of a DNA profile and its confrontation with a DNA database, is fully recognized and made use of. Both of these factors are comprised in the utility dimension: in both cases, previously available knowledge (either of analytical results or suspect identification) is considered when making the decision about the subsequent trace analyses.

Analytical thresholds, relating to the type of biological trace or the matrix it was collected on, have been proposed as criteria to guide the decision about the traces to analyse (Brown *et al.*, 2015; Mapes *et al.*, 2015). Such policies focus on the physical dimension and are close to black boxes, underestimating the impact of other dimensions, and in particular the situational ones. Knowledge about crime situations and observation of the practice of crime scene examiners reveal that decisions about the collection and analysis of traces are deeply conditioned by the understanding of the modus operandi. Purely technical criteria oversimplify the decision-making process by considering only one or two factors, related to the trace itself, without considering its integration in the overall case. More often than not, these factors have a negligible (if not opposite) influence on the decision-making process (Bitzer *et al.*, 2016). The matrix of the trace is not considered in the decision to analyse a trace and when studying the variation of analysis rate per matrix over time, huge fluctuations were observed, from one trimester to the next (Bitzer, 2016). These variations make its correct appreciation very difficult. The other factor related to the physical quality of the trace, its nature ('rich' versus contact trace), is however considered in the decision to analyse a trace; often, contact traces are chosen for analysis over 'rich' biological traces. This seemingly counter-intuitive result makes sense when considering the case circumstances: 'rich' biological traces—blood for instance—in robbery cases being often related to injured victims and not to the offender. Interestingly, it is in contradiction to the criteria proposed to guide the decision about the traces to analyse (Brown *et al.*, 2015).

Measuring the contribution of forensic science

Existing indicators to measure the contribution of forensic science consider essentially its use in the probative phase of the criminal justice process, its predictive power for judicial steps (arrest, charging, conviction, etc.), or its throughput regarding the technical procedures (number of performed analyses, number of yielded profiles). The results of these assessments are close to disastrous—forensic science is not or only rarely used, it allegedly has no impact on any of the considered steps—and depict overall a very negative image of the utility of forensic science (Home Office, 2007; Baskin and Sommers, 2010, 2012; McEwen, 2010; Peterson *et al.*, 2010; Strom and Hickman, 2010; ANZPAA NIFS, 2012; Brown *et al.*, 2015; Mapes *et al.*, 2015).

This outcome of the assessment is not surprising on two counts: first forensic science in many countries has taken a distance from investigative practice, by developing large laboratories focused on methods rather than purpose, and second because only court-oriented outcomes arising from forensic science are included in these studies. Both views combine to preclude any understanding of a wider-ranging utility. The exclusive utility dimension that is considered relates to building or strengthening the case against a suspect, and thus it is poorly integrated in the general process. Most of these studies were performed in a judicial system presenting a highly compartmentalized structure, leading to an implicit hierarchical scheme, between those deciding on the use of forensic science and those executing the measurements, which inhibits the necessary communication and collaboration leading to an inefficient integration and exploitation of the traces in the criminal investigation (Bradbury and Feist, 2005; Kelty *et al.*, 2015; Rossy and Ribaux, 2016).

The complexity of the criminal enquiry and the multiple potential dimensions of the contribution of forensic science should be taken into account to discover and measure the utility of forensic science which then appears much more diverse and nuanced, described within the individual steps of the decision-making process. Forensic science can contribute in manifold manners and have a substantial impact on the criminal justice process and beyond (Delémont *et al.*, 2014; Ribaux, 2014; Ribaux *et al.*, 2015). As mentioned previously, these dimensions can take obvious forms such as the identification of a suspect or its confirmation when he/she was previously identified. Forensic science (in its broad understanding including forensic intelligence) can itself influence the very first step of the process, notably the decision to attend a crime scene. The inference of a case belonging to a series of cases (e.g. sharing similar modus operandi as identified by the type of tool used) can engender a change in the perceived importance of the case and thus lead to its investigation by crime scene examiners and also can lead to preventive measures by alerting a population on precautions that may inhibit further crimes in a series.

When considering the contributions of forensic science in the investigation phase, one needs also to differentiate between cases which can be considered solved (in the investigative sense) before the analysis of collected traces, i.e. all suspects have been identified notwithstanding the fact that a given suspect is further charged or convicted for that offence, and cases where at least one person (author/suspect) remains to be identified before analysis. In these two cases, the potential utility of the clue prior to analysis is not the same. In cases that are considered solved with regards to the identification of the suspect(s), the utility dimension of identification is secondary and may not be pursued. Whereas in cases where at least one suspect still remains to be identified, one primary potential utility is the identification of the suspect.

In our study on robbery cases, the predominantly determined contribution appeared to be for identification purposes, followed by confirmation (Bitzer, 2016). Indeed, in 16% of these robbery cases, the first information regarding the identity of the alleged offender was determined by the results of trace analysis. When subtracting the cases that were solved prior to analysis (15 out of the 101 robbery cases were 'solved' prior to any analysis, through police enquiry), forensic science contributed to the identification of 16 out of 86 cases, or 19% of cases.

When considering solely the identification purpose, the utility of the clue can be questioned as, at the end, identification was achieved through multiple means, such as police enquiry and trace analysis, among which the contribution of the inquiry was more important. In 13 of the studied cases, hits (linking the suspect to the crime or the victim) were obtained, but the suspect had already been identified through police enquiry. In all of these cases, on the basis of the available information, the contribution of biological traces to the investigation could,

however, be attributed to confirmation or reconstruction of events.

Forensic science contributed further to case-linking in 21 cases. Compared with the 16 cases which contributed to finding the suspect, five additional cases demonstrated a crime-linking utility. One through shoe mark comparison, and four additional links through biological traces.

In addition to these obvious utility dimensions, there are several other indirect dimensions that are difficult to outline. An example is shoe marks—whose use as evidence for court was questioned by the PCAST report—which may provide valuable information for the collection of other traces. Their combination may play a catalytic role for the detection of other traces, revealing the path that was taken by a person (following one shoe pattern) and leading to the localization of contact points (catalytic role for the detection of traces). Shoe marks, or better their quick analysis on the crime scene, might also complement the offender profile provided by the police (i.e. shoe brand worn by alleged offender), and thus direct their investigations. Traces and their determination can also help establish the legal classification of the offense. In one of the cases we studied, a confession was yielded after the police investigator told the suspect that his co-suspect was linked to the case through a match between his profile and that extracted from the trace collected on the crime scene (role as a catalyst of information). This demonstrates the complexity of the contribution that forensic science can offer, far beyond the quasi mechanistic approach taken by many laboratories and institutions around the world.

Conclusion

Forensic science has been the focus of criticism over the past 10 years, sometimes for good reason, but most criticisms do not address the science question, but rather its end product as seen as evidence producing for the courts, or the practitioners and their laboratory methods to that end. We argue that the perspective is incomplete and fails to see the importance of initial detection of relevant traces or clues and their integration into the overall policies in charge of criminal investigation. In particular, looking at the utility and the decision processes involved, its usefulness becomes quite obvious since it relies on the sole remnant of a criminal activity: the traces that describe action and presence. An empirical study highlights the decision-making process and the integration of forensic science, from the start, involving a conscious reasoning regarding its usefulness. Utilities are defined and examples allow to demonstrate the value that forensic science can contribute in a variety of dimensions. The utility of the clue is a major indicator to describe the 'performance' of forensic science in a given investigation, as it acknowledges the various facets or dimensions of its usefulness.

The contribution of forensic science to the criminal justice system, or more precisely to the criminal investigation, should not be limited to single trace types such as the so-called 'gold standard' DNA traces, over fingermarks, or shoe marks and other trace types but should consider all trace material for its information content, with all facets of their potential contribution (identification, confirmation, crime linking, reconstruction, implication, etc.). Most of the attempts that have been undertaken to measure the usefulness of forensic science considered only one or two types of traces (mainly DNA traces and fingermarks) as they benefited mostly to court decisions. However, the other types of traces must not be neglected as evidenced by our limited empirical study, especially when considering contributions such as crime linking or reconstruction (e.g. shoe marks that unveil links between burglaries committed by the same perpetrator, fibres exchange that reveal contacts between an offender and a victim, chemical analyses of fire debris that demonstrate the deliberate character of a fire). Admittedly, the study that we undertook on robbery also focused on cases with at least one collected biological trace. This was,

however, necessary in order to investigate the influence of different decision factors leading to analyse a trace, in the specific case of biological traces. Nonetheless, the contribution of other traces could be highlighted especially during the participant observation phase that was also undertaken within our study, and through the investigation of the sequence of analysis of biological traces to fingermarks or shoe marks within a Swiss police organization.

In addition, the type of offence for which the contribution of forensic science is measured needs to be considered. For high volume crimes, the resources invested in regards to forensic science are often limited form the start, thus, forensic science is precluded from contributing in any way to the investigation of these cases. Nonetheless, the information conveyed by the traces could increase knowledge about criminal situations (by linking crimes through traces) and thus provide the incentive to put preventive measures in place.

Overall, the diversity of the dimensions of the utility of forensic science to the investigation is currently lying with crime scene examiners. Investigators and magistrates are fully aware of this fact, through their daily reality check embedded in the investigation of a variety of crimes, one reason for this being the high scientific content of trained scene of crime forensic scientists. The results obtained regarding the decision to analyse a trace show that the main utility of forensic science, when biological traces are concerned, is for suspect identification. In 19% of the cases, where no suspect identification was yielded through police enquiry previous to trace analysis, the results of this analysis delivered the first lead regarding the suspect's identity. In 15% of the cases, the suspect was identified through police enquiry previous to trace analysis. Nevertheless, the limited sample of cases showed the importance of other traces in investigative leads in one-fifth of the cases (21 out of 101 cases).

This paper, supported by our empirical studies, demonstrates a significant contribution of forensic science for anyone who cares to consider it through multiple angles. Not only for the criminal justice process—for which multiple dimensions of utility have been highlighted—but more broadly in the face of public security issues. And even in a broader social context, the practice of forensic science can play a role in reducing trauma and psychological harm that crime induces. This social function, though regularly witnessed by crime scene examiners, passes through the riddle of the existing measure of contribution of forensic science.

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