2 Forensic Philosophy

Karl Harrison[1]* and David Bailey[2]*

[1]*Cranfield Forensic Institute, Cranfield University, Defence Academy UK, Shrivenham, Wiltshire, UK;* [2]*Department of Forensic and Crime Science, Staffordshire University, Stoke-on-Trent, Staffordshire, UK*

2.1 One of Us Cannot Be Wrong: The Structure of Knowledge and Reasoning in Forensic Science

KARL HARRISON

2.1.1 Introduction

The purpose of this chapter is to consider how the science in forensics is structured. Forensics is a *crossroads discipline*, which encompasses a breadth of skills, from investigative scene examination to analytical chemistry, but despite the vital importance of establishing conclusive facts in a court of law, little has been written about how forensics produces facts or distinguishes them from observations and interpretations.

A scientifically educated professional, such as a veterinarian, considering the further development of their career towards a forensic specialism, might find themselves harbouring a curiosity regarding how forensic science works, how forensic scientists observe salient facts, how those scientists construct interpretations from said observed facts, and how those interpretations might be communicated, either in an academic context or via court testimony. Such curiosity might cause them to seek answers to these questions from either standard synthetic set texts (Lee *et al.*, 2001; James *et al.*, 2009; Pepper, 2010), or from articles in widely read peer-reviewed journals (Inman and Rudin, 2002; Crispino

*Corresponding authors: k.harrison@cranfield.ac.uk; daysbays@yahoo.co.uk

et al., 2011). In both instances, a reader new to the field would be forgiven for thinking that forensic science is a discipline solidly based on the quantification of the exchange of material traces, such as cellular DNA (Bond and Hammond, 2008), blood (Sikirzhytskaya *et al.*, 2013), glass (Howes *et al.*, 2014), paint (Wright *et al.*, 2013) or soil (Woods *et al.*, 2014a,b), or on the development of statistically robust techniques for presenting such evidence in court. Synthetic texts repeat some of this material, frequently in the form of introductory discussions of Bayesian statistics (Jackson and Jackson, 2011).

My thesis in this chapter is that, on the whole, this literature reflects the core concerns of a central bloc of laboratory-based forensic biologists, chemists and other scientists focused on trace evidence dynamics, and that these cited publications are primarily concerned with the development and refinement of method, rather than advancing or explaining the theories and concepts that might assist the generalist scientist in developing a clear and comprehensive understanding of what their place in forensic science might be. My intention here is to draw attention to the set of circumstances that has brought about the current theoretical framework in which forensic science resides, and consider it in the light of the discipline's historical roots, as well as to advance a broader discussion about what might be said to constitute science. In providing this discussion, I will also detail why I think this form of consideration is particularly important in the development of specialist forensic disciplines such as veterinary science, and in the professional development of individuals within such specialisms.

2.1.2 Forensics: a plethora of different sciences

Before I begin this discussion, I need to make a number of confessions that help to establish the context within which I have formed these opinions. Rather than coming out of biology or chemistry, my reporting discipline is forensic archaeology.[1]

Prior to becoming a forensic archaeologist, but subsequent to my training in traditional archaeology, I worked as a Crime Scene Investigator and later Scene Manager for two UK police forces. This small piece of personal history is important here for three reasons, I believe: first, forensic archaeology is a niche discipline, somewhat removed from the central pillars of forensic science, biology and chemistry; second, as a science, traditional archaeology has a long history of reflection and conceptualization, which I will argue later that, taken as a whole, forensic science does not; third and finally, the UK's Crime Scene Investigators are primarily employed by police forces, rather than the (now privately run) forensic service providers. While this makes them a part of the wider investigative process, it remains a moot point whether this role is included within broader concepts of forensic science.

My second confession concerns the third point above. Some years ago I wrote a paper entitled 'Is crime scene examination science, and does it matter anyway?' (Harrison, 2006). While this paper drew on the philosophy of science to consider the nature of crime scene examination and, more specifically, the role of crime scene investigators, its main purpose was political, rather than epistemological. I was motivated to write it because of general accounts of forensic science that seemed to gloss over the point of interaction between evidence collection by a CSI and examination by a forensic scientist (cf. Coyle and White, 2010), and was distressed to talk to CSIs content to take a minimal role in the scientific process. I found at the time that the models of what constituted science did not adequately encapsulate the forensic process. Crispino (2008) took issue with my conclusions, and offered abductivism, discussed below, as a model of scientific structure that more comfortably accommodated the process of crime scene examination.

Given the fragmentation to which I have eluded within forensic science, the first question I'd like to consider is what level of coherence as a discipline forensic science can be said to possess. In defining this first question, I have used a commonly ascribed definition of forensic science:

> Forensic science is science used for the purpose of the law ... The recently

> appointed UK Forensic Science Regulator has further expanded this definition to 'forensic science is any scientific and technical knowledge that is applied to the investigation of a crime and the evaluation of evidence to assist courts in resolving questions of fact in court'.
>
> (Rankin, 2010, p. 2)

By the term coherence, I mean the extent to which a central set of theories or theoretically-defined methods have developed, which identify forensic science to the exclusion of other, non-forensic science disciplines. It is perhaps interesting to note that Brian Rankin, in providing his introduction to forensic practice, regards it as important to specify a number of different roles in the forensic process, separating out forensic scientist from forensic practitioner and forensic medic, but does not consider what points of distinction define the parameters of these terms.

Central to this consideration is the observation that forensic science is defined by its context of application, rather than by any observed or defined boundaries to its subject of study. This is in contrast to a great range of other physical and natural sciences, such as biology, chemistry or crystallography, all of which interact and overlap, but are in some sense defined by their theoretically informed perspective on their subject matter. Perhaps the closest analogue to forensic science would be medical science, in that they are defined by their application, but medical science has perhaps a tighter focus on human biochemical systems. Criminology, a social science interested in concepts of laws versus social codes and morals, the development of legal frameworks over time and the nature of individual and corporate transgressions against laws, has been described in terms that directly parallel the nature of forensic science: criminology brings together psychologists, psychiatrists, sociologists and historians of law and crime into what Downes (1988) described as a 'rendezvous subject'; it being the subject matter that draws together disparate academics, rather than a shared framework of knowledge and methods.

There are areas where coherence can be seen to operate across broad swathes of forensic science. Locard's exchange principle, as refined by Kirk (1953, p. 4) has provided an overarching theory governing the transmission of trace materials for decades:

> Wherever he steps, whatever he touches, whatever he leaves, even unconsciously, will serve as silent witness against him. Not only his fingerprints or his footprints, but his hair, the fibres from his clothing, the glass he breaks, the tool mark he leaves, the paint he scratches, the blood or semen he deposits or collects. All of these and more bear mute witness against him. This is evidence that does not forget.

If there is a point of coherence borne out of theory, then it must be this: while it remains most pertinent to crime scene examiners and particularly examiners of trace materials, the obvious analogue being that the actions of a protagonist may be revealed by traces left on a host. This can be seen in disciplines as diverse as forensic archaeology, bitemark analysis or the study of mobile telephone cell sites. Locard's Theory gives forensic science coherence about how data is created (i.e. by human action on a subject, host or environment), and it defines our scale of interest (we want wherever possible to discuss actions or traces of an individual we might be able to name, identify or characterize in some meaningful way). What Locard's Theory does not do is define a unifying means by which forensic scientists might derive knowledge from this data.

Locard's Theory can be conceived as sitting at the highest level of theory held in common by much of forensic science. Below this it is possible to identify a range of methodological theories that essentially provide quality control and guiding principles across a broad range of forensic disciplines. These lower level theories encompass strategies of optimal searching or evidence recovery (Taupin and Cwiklik, 2011); concepts of primary, secondary and tertiary cross-contamination (Butler, 2011); and improvements to the understanding of trace evidential transfer between actors on a crime scene (Morgan *et al.*, 2010).

As the level of thinking continues to descend towards the application of forensic practice, this high level coherency diminishes. While acquired data is generated and tested against hypotheses, the manner of testing and types of knowledge constructed by different forensic disciplines is different, as each tends to relate back to a distinct 'parent' science. This may seem facile, but it is an important point to stress, as the growth in popularity of Bayesian approaches in forensic science (Taroni *et al.*, 2006), the importance of Daubert criteria in US forensic science (Grivas and Komar, 2008) and the development of specific guidance for Forensic Service Providers related to ISO accreditation standards (ISO/IEC, 2005) together provide a tension which uncomfortably pulls forensic science towards an agreed mechanism of data interpretation.

That scientific knowledge is in some ways more valuable than other forms of knowledge is a commonly held belief from which the philosophy of science sets out its stall (Bird, 1998; Chalmers, 1999). In this regard, science presented in the courtroom is no different. While 'normal' witnesses of fact might be asked to comment in court on what they saw, what happened to them, or on the character of a defendant, they are generally limited in their responses to their own experiences or perceptions (Wall, 2009). By contrast, the forensic scientist, while giving evidence within their area of expertise, is an expert witness, able to give evidence of opinion based on their findings on examination and their professional experience. As a professional expert operating in England and Wales, such a scientist would be expected to by familiar with and abide by the Crown Prosecution Service's guidance to experts (ACPO/CPS, 2010).

Forensic scientists are by no means the only experts recognized under this system; indeed, the system of classification is purposefully flexible to allow the broadest range of professional experience to qualify as an expertise. As forensic science has continued to develop and become ever more specialized, however, the notion that scientific reasoning might be able to provide a sound basis for expert opinion in the courtroom has become ever more commonplace.

2.1.3 The philosophy of science

Philosophy of science recognizes a number of schools of thought regarding structures of scientific reasoning: deduction, induction and abduction (Jackson and Jackson, 2011). Deduction outlines knowledge contained within logical statements, but in order to retain the integrity of these statements, the knowledge they shed light on must already be entailed within the structure of the premises of the prior statements, thus:

> Forensic evidence is recognized by the careful attention to detail at crime scenes.
>
> Forensic scientists pay careful attention to detail at crime scenes.
>
> *Therefore*
>
> Forensic scientists identify forensic evidence at crime scenes.

This statement makes logical sense, but the conclusion cannot give us any further information than that which is already entailed in the prior statements. While some forensic disciplines may rely heavily on aspects of deductive logic, particularly where they have a mathematical or geometric aspect to their functioning, such as angle calculation in blood pattern analysis (Bevel and Gardner, 2001), the structure of most forensic interpretation is not based upon deduction from logically entailed statements.

Induction, by contrast, attempts to derive scientific knowledge about universal criteria from the careful observation of smaller samples of relevant data. Observations are made via the senses and general patterns can be suggested in the form of hypotheses, and tested via experiment or further observation. Abductive reasoning combines elements of deduction and induction in order to fashion 'likely explanations', but it remains unclear what this process of generation exactly is (Jackson and Jackson, 2011).

Philosophers of science have noted limitations with the inductive model that are directly pertinent to forensic practice. In the Empiricist view of Locke and Hume (Carlin, 2009), facts exist as external things to be observed; they are fundamentally a priori, in that their existence is entirely independent from the observer, and precedes the act of observation. In the courtroom, the forensic scientist will report on and explain observations that form the basis of their interpretations; such explanations are vital, as without them, the observed facts alone might appear to be entirely incidental, or even invisible, to an untrained jury. Furthermore, even when a forensic scientist explains their observations, these may very well not be something a jury can see with their own eyes in a direct fashion; a DNA profile might be rendered as a series of numbers representative of allelic characteristics expressed at particular loci of the DNA molecule, or a trace of petrol detected in a sample of fire scene debris as a series of peaks on a chromatogram. Even with seemingly more obviously intuitive evidence types, such as the presence of toolmarks in the side of a grave revealed on a Crime Scene Investigator's photograph, the forensic scientist may ultimately describe diagnostic features of importance either not perceptible to an untrained eye, or not distinguishable as being any more valuable than any of the associated background 'noise', whether that noise be formed from other confounding peaks on the chromatogram, or natural variation in the soil that comprises the grave side.

The philosophical problem that is intrinsic to arguments based on induction is one regarding the weight of evidence placed on inference: to what extent is it possible to rely on or defend knowledge gained when it is based on reference to observations taken from a small sample, when ultimately it is being asked to apply to a much larger – or even universal – population? Such samples might be found in the small control DNA sample populations from which are derived the specific frequencies of different allelic characteristics, which in turn form the basis of match probabilities stated in court, or a software library of different accelerants from which a petrol sample might be identified. Falsificationism takes a sceptical view of this practice (Rosende, 2009), claiming that such observations can only establish a 'hypothetically adequate' conclusion, rather than advancing on a more conclusive truth. Any knowledge supported by such inductive observations only holds true until the first recorded observation of variance to the proposed rule; such as the discovery of a group of people possessing similar allelic characteristics that might alter our understanding of the frequency of such characteristics in a large unknown population.

In direct contrast with this sceptical view, abductivism (Crispino *et al.*, 2011) holds that structured inference to a best estimate is a satisfactory means of establishing scientific knowledge in a forensic context; although the notions of structured enquiry proposed by abductivists are in places so general that it becomes hard to distinguish between scientific observation and a rigorous, systematic but fundamentally non-scientific investigation.

Bayes' Thoerem has enjoyed considerable attention from forensic scientists and associated academics in the past 10 years (Taroni *et al.*, 2006), as it offers a means of providing a quantified probability of the occurrence of a given set of circumstances, based on an assessment of available evidence. This represents a very powerful tool for forensic scientists, as it offers a mechanism for the communication of technical interpretations to a jury of non-scientists. This power is balanced with a set of concomitant risks according to some critics (Kruse, 2013); the prior probabilities that define the preliminary calculations of Bayes' Theorem require fundamental scientific research in order to establish their values – such as in the shattering of glass from a window pane (Curran *et al.*, 2000). But these fundamental researches cannot account for the hypervariability of real-life scenarios. It is also possible that in attempting to assist a jury by providing them with a Likelihood Ratio, the forensic scientist might cause them to place more weight on the evidence, because it appears to offer a quantified, rather than qualified opinion (Anon., 2010).

There is a further distinction to be drawn between central tenets of Bayes' Theorem and its application in the context of forensic science. Bayes' Theorem offers an alternative means of supporting inferential arguments by turning qualitative observations into clearly defined quantified probabilities. Forensic scientists, by contrast, have applied Bayes primarily to express quantified opinions in court. While ambitious plans have been mooted to try to broadly quantify common variables (Gee, 1995), this has not occurred wholesale across forensic science.

It should be remembered that these theoretical discussions about what constitutes knowledge and science in a forensic context rarely impinge directly on the working life of the vast majority of forensic scientists, but rather present a broader background against which their methods of examination and parameters of interpretation develop. Legislative controls on forensic expert opinion in US courts under the Daubert criteria, and in the UK under Crown Prosecution Service Guidance to Experts, as well as the establishment of the role of the Forensic Regulator, and the growth in importance of International Standards (ISO 17020 for scene examination and ISO 17025 for laboratory examination) have all acted to provide a framework for the manner in which credible forensic science should be seen to operate.

2.1.4 Conclusion

The nature of what constitutes credible scientific knowledge in forensics cuts across a range of key debates that have a direct effect on the nature of practice, interpretation and dissemination in court: considerations of what are the distinctions between police investigation, crime scene examination and forensic analysis; conceptualization of what features are common and definitive across forensic science; and what constitutes a legitimate balance between qualitative and quantitative interpretation. There are no simple answers to these questions, but awareness of their existence clarifies the nature of forensic science to newcomer and established practitioner alike. In specialist fields such as forensic veterinary science, where practitioners move out of a strong parent discipline and into the 'rendezvous subject' of forensic science, these discussions are even more important, as they assist in providing an overarching framework of the discipline for scientists new to the field.

2.2 Junk Science

David Bailey

Seeing is believing.

2.2.1 Pseudoscience

Definition:
Any of various methods, theories, or systems, as astrology, psychokinesis, or clairvoyance, considered as having no scientific basis.

2.2.2 Junk science

Definition:
Faulty scientific information or research, especially when used to advance special interests.

One would not normally associate declining quality with increasing demand for a service. In court, however, in a feature of the adversarial system, what is bad for one side is almost invariably good for the other. Viewed from the right side of the aisle, bad expert testimony looks excellent and, while the views of opposing expert witnesses cannot be excluded from a legal dispute, there are problems for experts when they rely upon science that is just plain wrong. While some examples provided here are historical, the case study provided in Appendix 2.1 occurred in Northern Ireland as recently as 2007.

2.2.3 Conclusion bias

In 1895 W.C. Röntgen discovered X-rays; eight years later N-rays were identified and were named after the University of Nancy in France. Their discoverer, Monsieur René Blondlot, was a distinguished French physicist and a member of the French academy of sciences. He had detected N-rays by observing their ability to brighten an electric spark through which they were beamed. More than 20 other French physicists soon confirmed the discovery of N-rays and interest in this exciting development even surpassed the interest in X-rays.

In the 18 months following Blondlot's announcement, the number of publications on the newly discovered N-rays proliferated rapidly. In 1904 the French journal *Comptes Rendus* published three papers on X-rays but 54 on N-rays. A century later in 2015, we utilize X-rays in diagnostic imaging; however, after 1904, no one published anything further on N-rays. N-rays do not exist; they have never existed and are remembered chiefly for the insights they can provide into the fringe sociology of the competitive academic world of research. N-rays were discovered and subsequently rediscovered on more than 54 occasions because people *wanted* to see them. The methodology used in the experiments to describe them was flawed; yet so anxious were the scientists to declare the existence of N-rays that they chose results over methodology (Huber, 1991).

In another example, Anita Menarde had an accident on the morning of 16 May 1949. While alighting from a Philadelphia streetcar, she was slightly injured as she stumbled and later sued the providers of the streetcar service after developing breast cancer. Immediately after her fall she was treated at her local hospital for minor scrapes and abrasions to her left ankle, right knee and both hands. Upon undressing that evening she had noticed a discolouration on her right side and breast. She called her doctor about her bruised breast; he examined it, found no lumps and prescribed hot compresses. He examined her periodically for the next two months – the breast seemed normal.

At the end of July (ten weeks after her accident) she detected a lump in her breast at the same place as her earlier bruise. She was diagnosed with breast cancer and had a mastectomy. She was awarded $50,000 in damages from the streetcar service providers, having successfully argued that trauma causes cancer. By the time of her court case, this medical theory was almost three centuries old and about to be debunked as a cause of cancer. In 1676, an eminent English surgeon, Richard Wiseman, had reported two interesting cases of cancer. Both patients, he observed 'thought the cancer came from an accidental bruise' (Stoll and Crissey, 1962); Wiseman thought so too and he proceeded to identify bruises, errors in diet and 'ill handling' (Huber, 1991) as among the causes of cancer. By the late 17th century, many doctors had come to believe that simple trauma could trigger a malignant tumour in a human patient.

Yet, by the mid-19th century, the traumatic cancer theory was in decline. Most physicians were beginning to understand that among the causes of cancer, many as there were – simple trauma was not one of them. Like the discovery of N-rays, it was another hypothesis *on its way* to the museum of scientific curiosities. Then suddenly and without any scientific reason, there was a rapid shift in attitude among doctors in Germany and the US in the late 19th and early 20th centuries. In 1875 the scientific literature suggested that one in eight cancers were now caused by trauma. In 1897 nearly half of all bone cancers were now *caused* by trauma and in 1932 it was determined that two in five brain tumours (40%) were traumatic in origin or caused by simply being upset.

Whereas the N-ray was discovered to not exist by the one, singular correctly identified methodology and test experiment, there was no similar research carried out to disprove a traumatic cause of cancer. In fact there were now many scientific references designed to demonstrate that a traumatic cause of cancer could be demonstrated reliably. So what had changed?

In the late 19th century in Germany and the USA, *the laws had changed* and Germany had introduced the world's first workers' compensation programme. Combined with the introduction of health insurance for workers, a race began to determining the