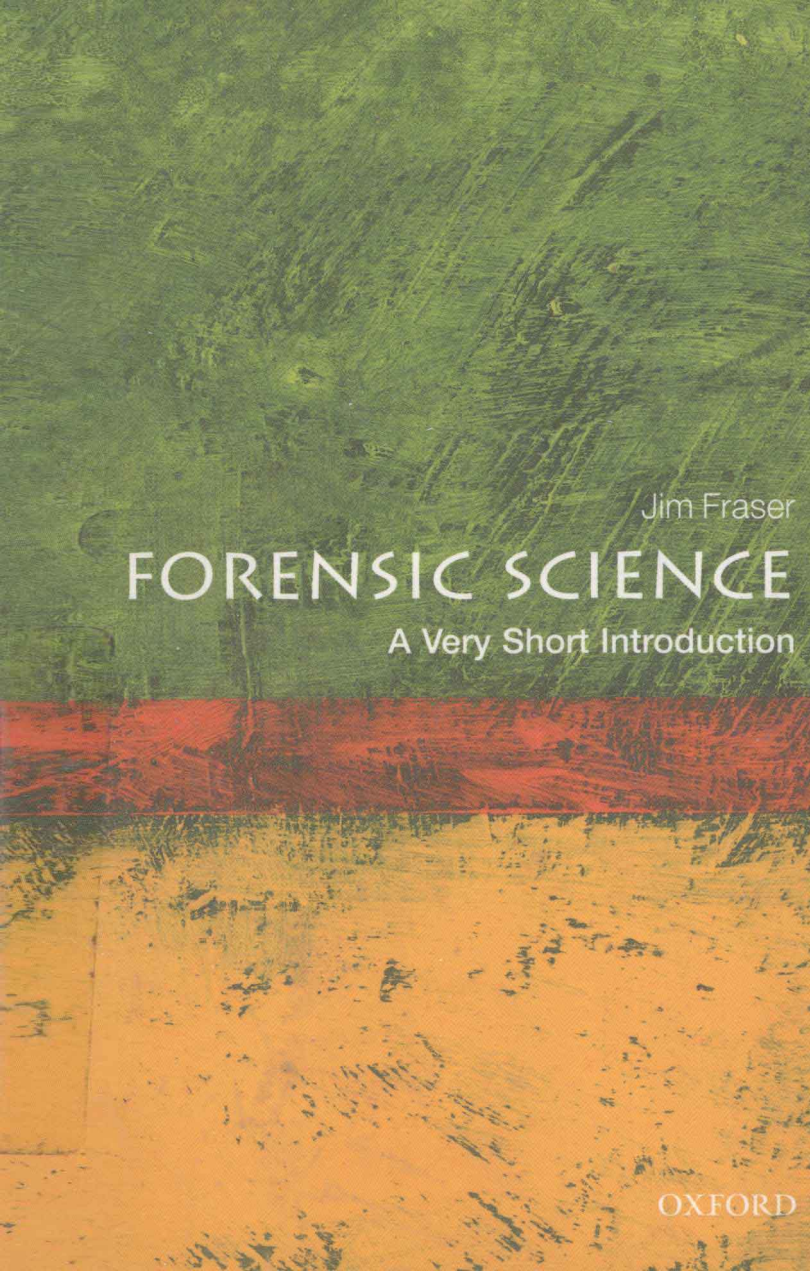
Jim Fraser
FORENSIC SCIENCE
A Very Short Introduction
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Preface and acknowledgements

There is more interest in forensic science now than at any previous time in its history. There are more students studying 'forensic' courses in the UK than ever before and there is a seemingly endless list of TV dramas that are testimony to huge popular interest in the subject. In real life, forensic science attracts enormous media attention in high-profile cases such as the deaths of Damilola Taylor, Jill Dando, and Rachel Nickel. More importantly, forensic science provides 'leads' in police investigations and evidence for prosecutions that were previously unimaginable. Despite this, understanding of forensic science is poor even amongst those, such as lawyers and police officers, who are required to use it as well as others such as politicians and journalists. Public understanding of the subject is largely based on TV shows, such as *CSI* (*Crime Scene Investigation*), which use hi-tech imagery for dramatic effect at the expense of understanding of an increasingly important part of the criminal justice process. There is even the so-called 'CSI effect' – that expectations and misconceptions about forensic science on the part of the public may have adverse influence on jury decisions.

Dramatic scientific breakthroughs, particularly the discovery of DNA profiling, in the past 20 years or so have revolutionized forensic science. Evidence can be obtained from microscopic traces of body fluids, drugs, and explosives of sufficient quality for it to

be pivotal in an investigation or trial. There has been a parallel revolution in how the police investigate crime. It is probably more effective, faster, and more reliable to investigate the crimes that affect us most (burglary, car theft, and suchlike) using DNA and fingerprints than by any other means. In major crime, such as homicide, forensic scientists have moved from being backroom boffins to the forefront of international investigations. Forensic science is now firmly embedded in the criminal justice agenda since it can answer investigative questions in many instances better than any other means available. It is a complex activity at the interface of science and law. Forensic science is not a discipline in its own right, but engages many disciplines such as chemistry, molecular biology, and engineering, though it has a number of distinctive features. Whilst rooted in science, it is an intensely practical activity that deals with real-world issues: explosions, blood spatters, bodies, and stolen cars. Complex scientific findings must be weighed carefully and dispassionately, and communicated with clarity, simplicity, and precision to police, lawyers, jurors, and the judiciary. Forensic science encounters all aspects of human behaviour. The famous headline 'all human life is here' fits forensic science very well: the plain stupid (the killers who panicked and re-buried a body for the third time in a flower bed in a graveyard); the unlucky (the man who wrote an anonymous threatening letter to the chairman of a London football club on paper with invisible indented impressions of his name and home address); to the cold and frighteningly malevolent – serial sexual offenders and killers who plan and fantasize about their crime throughout the course of their life (Anthoni Imiela and Robert Black). In short, forensic science matters because the link to everyday life (and death) is more direct, tangible, and visible. But forensic science does not have all the answers. In some instances, it has no answers at all (for example in the Michael Stone case), and in some cases it fails spectacularly and worryingly for reasons that are not always clear, for example in the Jill Dando case. Forensic science is also regarded ambivalently by some (as is science by the public in general) and by others as a source of injustice. The arguments of

the latter are rarely well informed in my experience, but I will explore some of these issues in this book.

It would be impossible to do justice to all areas of forensic science in a book of this type and length, so I have necessarily had to select some things and exclude others. Whole areas of forensic science are completely absent: toxicology, crash investigation, computer forensics, document examination, and others are dealt with superficially or in passing. In making this selection, I have attempted to identify the central issues of forensic science, such as identification and evidence evaluation, and its main procedures and mechanisms, such as continuity of evidence (chain of custody in the USA and many other countries) and minimising contamination. Many of the cases I have used as illustrations come from direct personal involvement and memory. I have not provided detailed information in every case as this is rarely necessary to gain an understanding, but in some instances the full details are already well publicized. It is my contention that you do not need to know the details of every area of forensic science to know the nature of forensic science. I will leave the reader to judge the success or otherwise of my efforts.

Although science uses more or less universal terminology, that used in policing and the law varies considerably even to the extent that the same word can mean different things in different jurisdictions. For example, the document containing forensic science evidence presented to the courts in England is called a 'statement', whereas the equivalent document in Scots Law is called a 'joint report' and a statement means something else. In Scotland, items produced in evidence are called 'productions', whereas in England, the USA, Australia, and many other countries they are called 'exhibits'. This is a constant problem when discussing or teaching forensic science. To overcome this, I have decided to abandon all attempts to be legally precise except where essential and have used common-sense terminology such as item (instead of production or exhibit) or report (instead of 'joint report'

or 'statement'). None of these infringements should impede understanding of the subject. The chapters generally follow the chronological flow of how forensic science interacts with the criminal law – incident, investigation, and laboratory analysis – from crime scene to court.

Finally, a word on those 'CSI' or 'eureka' moments – when the scientist 'cracks' the case with a piece of brilliant incisiveness and basks in the admiration of her colleagues. Yes, they happen, but far less frequently than TV dramas would have you believe. Perhaps five or six times in a long career this might occur. In truth, most cases are solved by a combination of systematic investigation by a range of professionals (police officers, scientists, pathologists, CSIs), good teamwork, effective leadership, hard work, and some luck. I hope this comes across from the text.

I am indebted to many for their support in the writing of this book: the initial reviewers, colleagues, friends, and all who provided advice, critical comment, and images. I wish to thank them all (in alphabetical order): Sarah Cresswell, Peter Gill, Jim Govan, Isobel Hamilton, Max Houck, Anya Hunt, Lester Knibb, Adrian Linacre, Terry Napier, Niamh NicDaeid, James Robertson, Derek Scrimger, Nigel Watson, Robin Williams. I would also like to thank Latha Menon for her enthusiasm in commissioning the project and Emma Marchant for seeing it through with me. Finally, special thanks to my partner Celia and son Robbie for their enduring patience when I should have been paying more attention to them and not locked in my study.

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Chapter 1
What is forensic science?

> The bloodstains looked like the scattered fragments of a mysterious pattern – a last message, a warning, the writing on the wall.
>
> Alec Ross, *The Rest is Noise: Listening to the Twentieth Century*

These were the words of Klaus Mann (the son of Thomas Mann) following his discovery of the corpse of his friend and former lover Ricki Hallgarten who had shot himself through the heart. Paul Kirk expressed a similar sentiment in even more detail and in more utilitarian terms:

> Wherever he steps, whatever he touches, whatever he leaves, even unconsciously, will serve as a silent witness against him. Not only his fingerprints or his footprints, but his hair, the fibres from his clothes, 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. It is not confused by the excitement of the moment. It is not absent because human witnesses are. It is factual evidence. Physical evidence cannot be wrong, it cannot perjure itself, it cannot be wholly absent. Only human failure to find it, study and understand it, can diminish its value.

Kirk replaces Mann's lyrical symbolism with anthropocentrism. Not only is there a story to be told but, according to Kirk, one

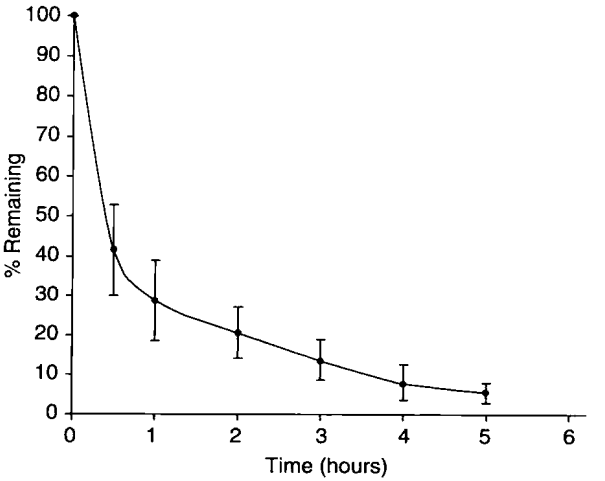
cannot fail to read it. This is what is referred to by my colleague Robin Williams as the 'forensic imaginary' – the conviction that all such events are knowable and can be reconstructed from forensic evidence, that there is always a decipherable last message from the victim and evidence from the perpetrator; the 'signature' of the killer. Mann considers the bloodstains to be not just symbols of violence but a 'text' that can be read and interpreted, and Kirk makes it clear that we cannot fail to do so.

The most influential thinker in forensic science was Edmond Locard (1877–1976), who almost certainly prompted Kirk's comments above. Locard established the first police scientific laboratory for investigating crime scenes in Lyon, France, in 1910. He also set out what many consider to be the fundamental basis and guiding principle of forensic science. This is most frequently formulated as 'every contact leaves a trace', although Locard never used these exact words. Directly or by implication, the message that is taught to police officers and the masses of new forensic science students is that these views represent reality: that there will always be evidence about such events, and ultimately that all things can be known about a crime or a criminal. Only failure on our part as humans can usurp this aim. Also, that this evidence is dispassionate, objective: not only will we know things, there will only be one version of the truth (and therefore no disputes). And we have the last laugh since all this can happen without the criminal even knowing.

From my experience of forensic science, it is difficult to imagine a situation that is much further from reality. Locard's principle as it is usually described is not a scientific theory because it cannot be tested by scientific means, and it cannot predict in the way that scientific laws such as gravity or electromagnetism can. Nor could it be described as a model of the world – we would need much more evidence than we actually have to assert this. It is more a principle based on a thought experiment. Like other 'scientific' principles, for example the cosmological principle, which makes

certain simplifying (but untrue) assumptions about the distribution of matter in the universe, the point of it is to help us think about things when we have little or no data to go on. What we do know is that research supports Locard's assertions in part but that there are also limitations to the application of these concepts. The flawed assumption is that once evidence is transferred it remains in place, because we know that this is not the case. Generally speaking, such evidence will be lost and often very quickly, perhaps a few hours after the event, as illustrated in Figure 1. We can therefore put forward as a genuine scientific theory, one that can be tested on the basis of empirical evidence, the concept of transfer and persistence. For example, when items of clothing come into contact, fibres will be transferred from each to the other and then gradually lost.

We have perhaps been a little hard on Locard and Kirk. So let's return to this thought experiment and imagine a world in which



1. Loss of fibres from the surface of the skin. This illustrates a pattern which is typical of fibre loss from many different surfaces. After five hours around 95% of the evidence has been lost

things are constantly being transferred, and as we now know also lost. I sit on a fabric-covered seat on a train reading a book. Fibres from my clothing are transferred to the seat and from the seat to my clothing. When I arrive in my office, some fibres which remain on my clothing from the train seat will be transferred to my office seat. So far so good, this is not too complicated, so let's continue with the experiment. Also being transferred to the train seat were fibres from my home environment, from upholstery, carpets, the clothing of my family, and perhaps hairs from pets. And on the train seat, in addition to fibres from passengers will be fibres from their homes, some of which will transfer to my clothing and perhaps to my office seat. The situation is now rather complicated. There are fibres in my office from people on the train whom I have never been in contact with and have never been in my office (although most of these will be lost on the walk from the station). There may be fibres from things in my home in other people's offices (who were also on the train). All of these fibres will be mass produced so none of them is unique. It should be clear now that finding fibres that match someone's clothing in my office does not mean that that person has been in my office. In fact, it does not even mean that they have come from that person's clothing. To make sense of any fibres that are found, we need to bring in some more up-to-date concepts in forensic work such as primary (direct) and secondary (indirect) transfer. The fibres transferred from my clothing to the train seat (and the reverse) are due to direct transfer. The fibres from other people's clothing on my office seat are from indirect transfer. So whilst every (direct) contact may leave a trace, traces may also be transferred which are not due to (direct) contact. Forming a view as to whether traces are direct or indirect contact needs a great deal more information, which we will explore in subsequent chapters. It should now be obvious that making sense of this requires the inevitable involvement of fallible humans, uncertain information, scientific tests that have inherent error rates, and subjective interpretation of test results. The final twist to this tale is that all of these activities, examinations, and interpretations must comply with the law and legal procedure.

This takes science from the laboratory directly into a very different world in which the interpretation of the scientific evidence may depend on the law. For although science is essentially universal – it is the same in Glasgow, New York, and Beijing – the law is local, sometimes astonishingly so. Furthermore, in common law systems such as those in the UK, USA, Australia, and Canada, the rules of evidence constrain what can be said and done in court, including what scientific or expert evidence can be presented. The law decides for itself what can and cannot be heard. And fundamental to the common law (or adversarial) process is the notion of argument: that there is inherently more than one viewpoint, position, or interpretation to any set of facts. The law is the final nail in the coffin for Kirk and Locard and any grand vision of uniqueness, objectivity, and infallibility. But we should acknowledge their originality, creative imagination, insight, and the influence they have had in inspiring scientists to develop more rigorous empirically based theories.

So what is forensic science? Definitions are not helpful here as at best they usually suggest a connection or interaction between law and science but do not provide any insight into the complexities or limitations of this odd relationship. From my perspective, it is better to describe than define. For me, forensic science is the investigation, explanation, and evaluation of events of legal relevance including the identity, origin, and life history of humans, materials (e.g. paint, plastics), substances (e.g. drugs and poisons), and artefacts (e.g. clothing, shoes). This is done using scientific techniques or methodologies which allow us to describe, infer, and reconstruct events. The basis of the reconstruction is the analysis and evaluation of indirect fragmentary physical evidence (what remains of the traces) and relevant information. From these facts, when established to some pre-determined legal standard, the law infers behaviour, motivation, and criminal intent. In short, forensic science answers the central questions in a criminal investigation: who, what, where, when, how, and why? Answers to these questions include the identity of the criminal or

victim using DNA or fingerprints, what type of shoe left the mark at the crime scene, the sequence of events that led to a death as established by bloodstain pattern analysis, where a shot was fired from, or how a fire has started from a scene investigation and why it burned so fiercely from analysis of flammable liquids. We will consider many of these issues in more detail in subsequent chapters, describing the processes involved, the methods of analysis, how the evidence is interpreted, and ultimately how it is presented in court.