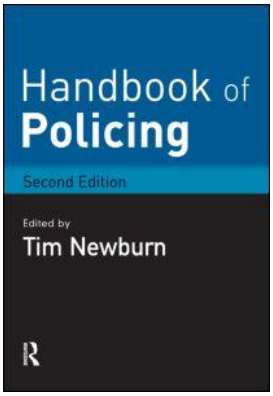

Handbook of Policing

Tim Newburn

Policing and forensic science

Publication details
https://www.routledgehandbooks.com/doi/10.4324/9780203118238.ch28
Robin Williams
Published online on: 01 Aug 2008

Chapter 28

Policing and forensic science

Robin Williams

Introduction

It is difficult to exaggerate the level of enthusiasm with which a variety of contemporary policing stakeholders commend the actual and imagined uses of forensic science to support the investigation of crime and the prosecution of offenders (see, e.g. Home Office 2003; ACPO 2005; Forensic Science and Pathology Unit Home Office 2005; Green 2007).[1] However, the claims, expectations and desires underpinning this enthusiasm contrast markedly with a series of critical commentaries that question the presumed epistemic authority of many fields of forensic science, and dispute claims that their technological applications to the justice process are always and necessarily positive. Recent studies by Cole (1998, 2001, 2004), McCartney (2004, 2006a, 2006b, 2008), Murphy (2007) and Thompson (1993, 1995, 1997, 2005) have all pointed to the dangers of misplaced confidence in many of the claims to scientific certainty that accompany the deployment of specific forensic technologies, and the consequent risk this poses to the criminal process. As an instance of the latter concern, Gerlach's account of DNA profiling argues that support for the developing uses of this exceptionally powerful forensic innovation has been informed by, and has further impelled, the new forms of instrumental rationality that have come to dominate the criminal justice process of several contemporary democracies. In these new forms the increasing reliance on science (often proprietary science) for the management of socially problematic individuals and their fiscal costs to the state, represents 'a shift in legal regimes away from an ideal type based on political value about the relationship between the individual and the state toward one based on values imported from the technological, scientific, and corporate domains' (Gerlach 2004: 91).

Others (e.g. Saks and Koehler 2005; Kiely 2006) have pointed to the absence of stable underlying principles and/or an inadequate empirical research base for many traditional (and some novel) forensic science applications, albeit that these shortcomings may be capable of correction in some cases in the short or long term.[2] The details of these disputes are beyond the scope of this chapter,[3]

but the following pages will explore some of what is known (or at least asserted to be known) about the ways in which a variety of forensic science resources and their modes of application currently contribute to criminal investigations and prosecutions in England and Wales, uncovering the main determinants of these uses, and considering ongoing efforts to evaluate and shape their operational effectiveness.

Several key developments in modern policing discussed elsewhere in this Handbook (and in the more general literature on policing) are relevant to this exploration since these developments have influenced the ways in which policy and practice in forensic science has been shaped by relevant actors and agencies. They include: an increasing emphasis on effective crime control as the central task and measure of successful policing (see Maguire, this volume); the use of government imperatives to centralise individual force policing strategies (see Jones and Newburn, this volume); the deployment of managerialist and audit perspectives to fund, organise and evaluate policing activities (see Golding and Savage, this volume); the growth of 'intelligence-led' policing (see Tilley, this volume); and the increasing internationalisation of policing operations (see Walker, this volume). In addition, there are also several features specific to the imaginary of forensic science, as well as its practical organisation and governance, which influence professional and public perceptions of its place in contemporary policing. Belief in this imaginary has energised the 'scientification of policing', understood as a belief in the epistemic authority of science and its capacity to resolve uncertainty and ambiguity in accounts of human conduct. In turn this has fuelled the restless development of novel forms of expertise, and the integration of such expertise into the existing organisation of police – especially investigative – activity. Finally, new challenges for the deployment and governance of forensic science have arisen as the corollary of recent government action to facilitate the emergence of an increasingly commodified and marketised form of provision to serve police needs.

Forensic science, crime scene examination and criminal investigation

Fundamental to the capacity of forensic science to contribute to the investigation of crime and the prosecution of offenders is the repertoire of observational, documentary, and collection practices that make up 'crime scene examination'. The 'crime scene' is the primordial site of operation[4] for the application of all forensic science disciplines and their associated technologies, and the term is used to refer to a variety of geographical locations persons and objects, including

> a piece of land or part of a street; a building, or a room within a building; the houses, vehicles, vessel and other property of a suspect, witness, or victim; stolen or recovered property; the body, personal possessions and clothing of a suspect, witness or victim; ambulances or other vehicles used to convey victims or offenders to hospital premises, police stations or mortuaries'. (ACPO 2005: 12)[5]

An understanding of the uses of forensic science to support the investigation of crime therefore needs to begin by identifying which individuals and groups most closely engage with this site as well as the forms that their engagement take.

All police forces in England and Wales employ a specific cadre of staff trained in the repertoire of practices that comprise the examination of such scenes. Variously known in England and Wales as 'crime scene examiners', 'crime scene investigators', 'forensic investigators', 'scientific support officers' or 'scenes of crime officers', such individuals comprise a largely civilian group within the wider police workforce.[6] Although investigators may consider calling on external specialist laboratory trained scientists to assist them whenever they identify the need for additional expertise (and then almost exclusively in support of the investigation of the most serious criminal offences),[7] it is these in-force personnel who undertake the bulk of forensic science work at crime scenes.

This contemporary professionalised and civilianised provision can be differentiated from the essentially pragmatic, experiential and craft based nature of early police investigative practice in which attentiveness to the preservation and forensic examination of scenes of crime was rudimentary (see Fosdick 1915; Morris 2007). An early twentieth century overview of forensic science resources for investigators was provided by Gross' *Criminal Investigation: A Practical Textbook for Magistrates, Police Officers and Lawyers*, first published in English in 1924, and reprinted in 1934, 1950 and 1962. However, until the inter-war period, forensic science provision was largely available to the police through the work of independent scientists, police surgeons and medical practitioners. This situation began to change in 1935 with the establishment of the first Police Laboratory in Hendon, and in the following four years the Home Office established other laboratories in Birmingham, Bristol, Cardiff, Nottingham and Preston in which the scientists were not directly employed by the police.[8]

A Home Office instructional pamphlet for the use of police officers published shortly after the end of World War II (Home Office 1949) provides a sense of early official support to claims of the usefulness of specialist forensic science within policing, arguing that

> science... may give certainty amidst apparently conflicting stories from witnesses, and at the very least it may provide a means of reconstructing the crime and thus saving an immense amount of unnecessary work for the investigating officer, by eliminating lines of enquiry which would otherwise require attention and pointing to those which are most likely to be fruitful. (Home Office 1949)

The nearest equivalent to this post-war pamphlet in current use is the *Scenes of Crime Handbook* published by the Forensic Science Service (1994), and a comparison between the two documents provides a clear sense of the change in the framing of forensic science support over the intervening years. For the Chief Executive of the Forensic Science Service this handbook aimed 'to encourage police forces and the FSS to work together to make the most

effective and efficient use of forensic science', and it is clear that this contemporary publication assumes a readership informed by technical knowledge acquired through formal training as well as operational experience. It focuses attention largely on techniques for the sampling and preservation of trace material to be collected and forwarded for subsequent laboratory examination, and the most recent edition has an important highlighted section dealing with issues of contamination avoidance, an issue of increasing significance as methods of DNA testing become increasingly more sensitive. Most importantly, and in marked contrast to the longevity of some of the previously mentioned texts, this publication has been substantially revised three times in the last eight years. In this way it testifies to the increasingly rapid pace of change in this techno-scientific field.

Contemporary crime scene examination requires immediate and ongoing decision-making about what particular observational, documentary, and collection procedures should be undertaken on each of the variety of locations, persons and objects that comprise the scenic particulars of the crime in question. Each successful application of such procedures produces one or several artefacts which may be subjected to further and subsequent analysis and comparison, either by the crime scene examiner concerned, or by other force or laboratory specialists. Typically such artefacts made by crime scene examiners during the course of their work include: photographs of places in which crimes had occurred, more detailed visual records of crime-relevant objects and appearances at such scenes and of physical injuries to victims;[9] plaster casts of footwear impressions left in soil or other soft surfaces; 'lifts' made from fingermarks left on surfaces which had been first powdered to develop the features of the mark before being transferred to an adhesive acetate and then backed by another acetate; footwear 'lifts' made by powdering hard surfaces on which the impressions of footwear marks are already faintly visible to the naked eye, and then collecting such enhanced marks through the use of acetate adhesive or Electrostatic Lifting Devices; fibres from clothing or other textiles thought to be relevant to actions or persons at the scene; moulds of tool marks; and samples of biological material taken either by swabbing visible stains at relevant areas of the scene, or by seizing material objects (especially clothing) on which such biological traces are thought to have been left.

Decisions to construct these artefacts at a crime scene, or to seize objects from which other artefacts may subsequently be made, are subject to a complex set of considerations. These include the time available to the examiner to undertake the work, the physical conditions of the crime scene in question, knowledge of the repertoire of collection techniques, the ownership of distinctive technical skills, and the availability of particular technological resources. These material considerations are supplemented by several cognitive ones. The most important of these is the prospective orientation of the scene examiner to a set of likely investigative and evidential trajectories to which these artefacts may become decisive – or at least relevant. In addition, even where such artefacts are assumed not be usable for the construction of a case against an actual or potential suspect for a particular crime, scene examiners still have to consider whether or not their construction and analysis

may contribute to the collation of police intelligence relevant to current or future investigations of other crimes. For example, a footwear mark might not reveal sufficient individualising detail to allow an expert practitioner to assert its match to a particular shoe, but it might be useful to know that examiners have found what seems to be the same type of shoe in marks left at three of four recent burglaries in the same geographical area. In addition, where those committing a series of recent burglaries have used an especially distinctive tool (even where recovered tool marks will not permit the individuation of a particular instance of such a tool) the seeming commonality of use may provide grounds to infer a common perpetrator for a series of such crimes.

The increasing interest in both investigative and prosecutorial uses of forensic science has generated a series of efforts to produce generic theoretical accounts of exactly how the authority of such work, in particular the construction and utilisation of standardised artefacts, may be assured. These accounts have been ratiocinative – and stipulative – in character, although inevitably they differ significantly in the cognitive principles that they assert as central to adequate practice. For example, Jamieson (2004) begins his advocacy of hypothetico-deductive theorising as a cognitive model for the process of crime scene investigation by arguing that the searching of crime scenes, and the construction of forensic artefacts, is always and necessarily preceded by the existence of some explicit or implicit hypothesis capable of explaining the events observed in the developing course of the examination. He then goes on to argue for the necessity of assessing the adequacy of one or a series of such hypotheses by comparing the predictions of what should be observable if they are correct (or at least which may be discarded by the discovery that predicted observations were not forthcoming): 'Ideally the tests should be devised to differentiate acceptability among the competing hypotheses in the smallest number of tests. These tests include searching for confirmatory or exculpatory evidence at the scene' (Jamieson 2004: 4).

For others, however, there is little to be learned about adequate crime scene examination practice by the application of a formal model whose relevance rests on the ability of its users to identify relevant physical laws, accurately describe a set of relevant material conditions, formulate logical connections between these two, and establish ways of definitively testing and retesting the adequacy of all of these matters – all in the relatively uncontrolled and heavily contaminated environments of typical crime scenes. For Ginzburg (1980, 1983, 1990), the emergence of such an occupational practice represented a conjunction of longstanding semiotic and conjectural forms of practical reasoning 'oriented to the analysis of specific cases which could be reconstructed only through traces, symptoms and clues' (1990: 104). Elsewhere, Ginzburg (1980: 28) also describes the 'elastic rigour' of the principles of crime scene examination, and comments on the ways in which in practice it combines a range of scientific and technical procedures with extensive tacit and weakly articulated knowledge of individual cases and their local contexts. Similarly, Kirk (1963: 235) argued that its underlying logic lacks the codification, co-ordination and systematisation required to set it on a firm theoretical foundation, but that it comprises a 'large assortment of effective technical procedures'.

Nordby (2000), Eco (1983) and Truzzi (1983) have all argued that the reasoning processes utilised in this aspect of forensic investigation are best understood as instantiations of Peircian 'abductive' inferences previously associated especially with the more 'conjectural procedures of physicians and historians' (Eco 1983: 205). For Peirce, the existence of particular facts can never successfully be explained inductively by inferring a rule for their formation from a collection of individual instances of their occurrence. However, they can successfully be explained 'abductively', that is 'by the provisional entertainment of an explanatory inference, for the sake of further testing' (Eco 1983: 206). In Peirce's own formulation: 'The surprising fact, C is observed; but if A were true, C would be a matter of course. Hence there is reason to suspect that A is true'. For Nordby, such ratiocinations lessen but cannot remove such doubt. The codified rule that comprises the hypothesis must still be subjected to further test, although the action of testing encourages further exploration of the details of the case under examination and those that seem similar to it. A whole series of such modified sequences may be necessary before investigators are seemingly able to establish a credible account of the underlying orderliness from which the individual observations in question can be shown to be derived.

Eco's observation of the significance of 'conjectural procedures' in this context resonates strongly with the suggestion that the two most important underlying assumptions of the work of crime scene examiners are best understood as proto-scientific conjectures in character, rather than as the law-like propositions or formal reasoning procedures on which stable forensic scientific inquiries might be thought to rest. These underlying assumptions, that 'exchange always occurs' and 'individuation is always possible', are the central resource used by examiners not only to direct and account for their own ongoing conduct, but also to control the conduct of others involved in the crime or the examination of its aftermath – witnesses, victims, suspects and other investigators. In addition, there are also direct and indirect references to the substance and significance of these proto-scientific propositions throughout the local instructional manuals and in quality assurance guides used to guide and assess the work of crime scene examination. In sum, it is the attentiveness to these proto-scientific conjectures that really provide for the methodical and accountable character of what competent scene examiners do (and refrain from doing) at crime scenes.

An increasing number of texts are available which provide the necessary scientific and technical background to contemporary crime scene examination as the 'set of effective technical procedures' alluded to earlier in this chapter. Known in the United States of America as 'criminalistics', a large number of textbooks, encyclopaedias and handbooks provide technical support for the initial training and subsequent professional development of crime scene examiners.[10] Recent US examples include Inman and Rudin (2001), James and Nordby (eds) (2003) and Gardner (2004). The recent explosion of undergraduate and postgraduate courses in forensic science in England and Wales has also led to an increase in the number of such texts, the most heavily used of which are Jackson and Jackson (2004), Pepper (2005), and Langford *et al.* (2005). Claims for the significance of criminalistics can seen in the tendency of

these and other such texts (e.g. Fisher 1995; Lee *et al*. 2001; White 1998) to make either or both of two recurrent assertions. The first of these claims the growing importance of forensic science evidence for the successful detection of crimes and prosecution of offenders; the second reports the persistent failure of many investigations to collect or make use of potential physical evidence available at crime scenes.[11]

Whilst such research has provided forensic investigators, analysts and other participants with important information about both the potential and the problematics of particular techniques and methodologies, it has not been concerned with either the pragmatic detail of naturally occurring crime scene examinations, or the actual uses made by police investigators of the products of such examinations. There are four matters which are overlooked in the absence of such considerations. First, the use of cognitive presuppositions and local practical reasoning by examiners to structure the process of scene examination and the recovery of physical trace evidence. Second, the human and circumstantial contingencies that arise and are dealt with in the course of such examinations by the application of relevant improvisational skills. Third, the responses of staff to the multiple exigencies that arise in the processing and reporting of such physical evidence by individuals and agencies independent of scene examiners. Finally, the varying organisational influences on the activities of police investigators and prosecutors which condition their expectations and their likely uses of the products of crime scene examinations. An understanding of all of these issues is relevant to an adequate interpretation of the organisational trajectories and uses of forensic science support to policing. Accordingly, the next sections of this chapter consider what is known about the quality of current crime scene examination in England and Wales and the ways in which its material and cognitive derivatives are deployed within the wider processes of criminal investigation.

The dynamics of crime scene examination

A variety of guidance documents are available to examiners which suggest ways of ordering the collection of specific kinds of evidence,[12] along with specifications of what parts of crime scenes are likely to be the most productive reservoir of such evidence.[13] However, as the authors of an early UK study of crime scene examination noted,

> almost all scene examination is less than fully comprehensive, since exhaustively combing every scene for any contact materials is clearly impractical. Prioritisation in scene examination seemed generally to be *ad hoc*. SOCOs value the professional autonomy to determine what should be examined and collected from the scene of an incident. (Tilley and Ford 1996: 18)

Williams' (2002) ethnographic observations of a large number of scene examinations conducted in a division of a Constabulary in the North of England described the ways in which examiners structured their selection

practices through an orientation to the cognitive reconstruction of the sequence of events that occurred in the course of each crime investigation. This was achieved by the interpretation of a variety of material signs of movement and activity within scenes, the application of accumulated knowledge of a repertoire of typified and standardised *modus operandi* for the crime in question, as well as the use of general background knowledge of such crimes. An orientation to such a reconstructive process has long been referred to in texts on criminal investigation, and Locard himself wrote of 're-creating' the criminal from traces left, but the seemingly intuitive and fugitive nature of the process has meant that it has not been the subject of detailed assessment.

Whilst crime scene examiners fully recognise the likely imprecision of such reconstructive practices, they also argue for their generic usefulness in shaping and focusing each particular examination by reducing what would otherwise be its almost indefinite scope. This is especially important when they make professional judgements about scene searching in the light of their knowledge of scarce resources, the range of alternative demands on their time and a concern with the measurement of individual and group performance by the use of a restricted range of indicators. These judgements are informed both by prior understandings of 'normal' or 'typical' crime scenes and the constant comparison of such *a priori* expectations with the emerging details of the particular scene in question. What scene examiners seek and value is an ability to deploy an intelligent and methodical process that avoids the dogged application of a preconceived expectation of the nature of any particular scene and which facilitates the flexible use of their particular professional skills.

A number of studies have sought to consider more fully the nature and implications of the professional autonomy of the work of crime scene examiners, most of which have begun by documenting wide variations between the productivity of crime scene examiners both within and between police forces, especially in the effectiveness of their deployment of the two forensic technologies most widely used in the investigation of crime and the prosecution of offenders – the recovery of fingermarks for fingerprint comparison, and the recovery of biological samples for DNA profile construction and matching. Following critical comments of the cost-effectiveness of current levels of performance made in the two Inspectorate Thematic Reports produced in the early years of the current decade (HMIC 2000, 2002a), the Police Standards Unit have developed an increasingly robust repertoire of 'forensic performance monitors', the application of which has demonstrated the continued presence of significant differences in the recovery rates and the processing timeliness of these forensic artefacts.

The issue of 'timeliness' – the speed at which forensic artefacts are examined, results obtained, and subsequent actions taken by investigating officers – has been a constant preoccupation of policy and operational stakeholders in forensic science, and so has often featured as a focus of interest in evaluative and research studies of forensic practice (see, e.g. HMIC 2000, 2002a; Prime and Hennelly 2003; Morgan *et al.* 2004; Williams 2004; Webb *et al.* 2005; Bond 2007b). Whilst all these studies have assumed – or outlined in preliminary detail – the benefits to be obtained when one or both of the most common artefacts constructed by, or on behalf of crime scene examiners –

fingerprints and DNA profiles – are subject to faster laboratory and bureau processing, only the most recent of these (Bond 2007b) has provided the kind of rich data that facilitates a detailed and critical exploration of the extent and nature of such benefits. However, in so far as this experimental study involved both an increase in the proportion of (domestic burglary) crime scenes examined and a decrease in the time taken to process fingermarks and DNA samples produced from these scenes, it is not always easy to separate the effects of these two different experimental measures. Nevertheless, the data do allow the author to conclude that 'the number of DNA hits and fingerprint identifications rose during the study period, which means that investigating police officers were able to result more intelligence in a quicker timescale than in the benchmark' (Bond 2007b: 295).

A further collection of studies by Bond and his colleagues (see Bond 2007a, 2008; Adderly and Bond 2008; Bond and Hammond 2008) have begun to open this field to more detailed scrutiny. This research has used a range of forensic and other data routinely gathered within one particular English police force in order to consider a number of questions about the quantity, quality, relevance and deployment of its routine forensic science support. Some of these papers seek to consider aspects of crime scene examination with attributes of the location being examined, as well as test the accuracy of crime scene examiners' own perceptions of the patterns of their attendance and forensic artefact recovery rates. For example, Adderley and Bond (2008) found that, contrary to the common perception of crime scene examiners themselves, the time that they spent at burglary and car crime scenes did not vary according to the social value (or degree of deprivation) of the neighbourhood in question. The prior assumption of examiners that their ability to recover fingermarks was directly related to deprivation level was also shown to be false, although the study did find evidence that more DNA was recovered from crime scenes attended in less deprived areas of the police force concerned. Whilst these findings are difficult to interpret since they infer many attributes of victims and circumstances that are not directly tested (and the results may even be subject to the effects of an 'ecological fallacy'), they certainly provide initial explorations (and test conventional understandings) of the relevance of a series of contextual factors that impinge on the process of crime scene examination. In this way they provide path-breaking studies of the complex social character of what is sometimes perceived as a largely technical accomplishment.

Other publications in this collection have provided detailed accounts of the social and technical factors that determine the effective use of particular kinds of forensic artefacts constructed by crime scene examiners. Two of these (Bond 2007a and Bond and Hammond 2008) focus attention on DNA samples collected at crime scenes and considers a series of variables assumed to affect the likelihood of detecting crimes on the basis of matches obtained between profiles derived from such samples and profiles of individuals already held on the National DNA Database. These variables included: the sources from which samples were obtained (blood, cigarette ends, saliva, chewing gum, hair, semen and a residual category of 'cellular material' where the origin of the sample cannot be attributed to any of these sources); the availability of samples from more than one such source; the location of the sample recovered relative

to the crime scene; the accredited experience of the police investigator; and the accredited experience of the crime scene examiner who collected the original material. The research showed both that the likelihood of obtaining a profile from different sources varied according to the experience and accreditation of the examiner that collected the sample, and also that the value of several of these material and organisational variables determined the extent to which a DNA match from the profiles obtained led to successful detections. Not only were some sources more successfully profiled than others, but also profiles obtained from some sources were more likely to lead to detections than those from other sources. The most likely being blood, and the least likely, what the author refers to as 'mobile' sources that could more easily have been transported to crime scenes by means other than the perpetrator. Moreover, this difference in results was magnified when more than one material source of DNA was available for comparison. In addition to these technical features and competences, one organisational factor was also shown to condition the likelihood of successful detections independent of the source effect. This key factor was the 'experience and accreditation' of the investigating police officer (but not the experience and accreditation of the crime scene examiner). Except where the DNA source was blood (where the evidential value is incontestably significant), officers with 'investigative accreditation' which necessarily required at least four years of service, showed a statistically significant greater likelihood of converting DNA matches to detections than did those without such accreditation. Although no further detail is provided of how such differences occurred, it seems likely that interviewing practices, especially the ways in which details of the nature of available DNA evidence are introduced into such interviews, are probably the most likely source of variation.

Police perceptions of forensic science

The technological optimism that characterises the criminalistic perspective on crime scene examination described earlier in this chapter – even as tempered by a small number of empirical studies of the work of crime scene examiners mentioned above – contrasts with reports of the rather more mixed views of the usefulness of forensic science held by some police staff. If crime scene examination is largely a matter of the preservation and construction of a series of physical artefacts alongside a contemporaneous written record of observations made and actions taken by the examiner at the scene itself, then other investigators will need to put this work to further use. Police investigators may generally agree that the collection and analysis of physical evidence can make a significant contribution to the detection of serious crimes (especially those for whom a clear suspect is otherwise unavailable). However, at least until recently, they have continued to assert that the detection of less serious forms of crime has rested on more traditional informational forms (e.g. surveillance, informants, undercover observations) directly instigated or controlled by detectives rather than by crime scene examiners or forensic scientists.[14]

For example, when referring to the practice of cold searching crime scene fingermarks, Manning (1977: 270) asserted that 'The use of latent fingerprint

or voiceprint information to establish suspects is largely a media myth', and elsewhere he commented that 'Typically, the establishment of a set of suspects, a detective job, narrows the number of persons against which the sample . . . print can be matched' (Manning 1977: 295 fn. 4). Whilst his comments on the effort involved in matching scene marks to fingerprint records in the absence of a limited pool of suspects (at least prior to the introduction of computer assisted searching some time after his commentary) are broadly correct, his description of the development of a set of suspects as a 'detective job' glosses over the potential sources of information (including forensic information) which detectives may now regularly draw on for such work.

Another study, a few years later still found police officers less than enthusiastic about the nature of the support provided to them by forensic science. Ericson's (1981) study of detectives in a Canadian municipal police force examined 295 cases including 179 cases of property crime, he (or the detectives he studied) showed limited interest in the production and use of forensic information. Thus according to his account, 86 per cent of the total cases 'involved no physical clues whatsoever', and fingerprint evidence existed in only 1 per cent of cases. When physical evidence was available, investigators used it in about a quarter of such cases, 'mainly to assist in identifying a suspect, inducing a confession, and/or as evidence in court' (Ericson 1981: 92 fn. 9). Ericson's detectives argued that its contribution to investigation was much less significant than information provided by uniformed officers, informants and victims. In a separate section of his research reporting on the production of suspects, Ericson fails to provide detailed figures for the contribution of forensic identification, but the tabular results suggest that it played a very minor role indeed in comparison to information provided by uniformed officers, informants and victims. However, these data are vulnerable to two obvious sources of bias. The first of these arises from the selectivity of investigators' recollections of the detailed course of crime investigations. This is especially problematic where case development may have arisen in the course of unrecorded briefing meetings or even less conversational episodes which are more typical in the investigation of volume crime. Another arises from the blinkering effect of differing occupational traditions that inform the general work of detectives on the one hand and that of crime scene examiners on the other.[15] Equally, a British study – of Devon and Cornwall Constabulary – conducted a decade later (Morgan 1990) suggested that fingerprint examinations at scenes of crime (including all crimes) resulted in identifications only in about 5 per cent of cases. Ericson concluded the relevant section of his study by commenting that the availability of physical evidence was both 'helpful in the prosecution sense of achieving guilty pleas', and also provided corroboration 'of other evidence that had brought the suspect to initial police notice'. However, he simultaneously characterised its contribution as numerically insignificant since it was 'used' in less than one per cent of serious cases (1981: 86–9).

A more recent sociological analysis of the process of criminal investigation – in this case the investigation of criminal homicide in the UK – has provided a more positive account of police views of the role of forensic science as one of several 'technologies of knowledge production' used in the investigation of

such serious crimes (Innes 2003).[16] In this study (and in a related unpublished report), Innes describes how forensic science evidence and its interpretation by experts is nowadays attributed particular value by the police and also how such information is used by investigators to confirm or disconfirm their own views of criminal actions and identities as well as to reshape or extend their preferred accounts at various stages of an investigation:

> The search for contact trace materials is framed by the existing knowledge held by an investigation, but in turn the analysis of these traces often causes alterations in the details of the narrative that is being constructed. Because evidence based on contact trace materials is often held to be more objective than alternative sources of evidence, it is frequently pivotal in the narrative, establishing and warranting some of the key facts of the police account. (Innes 2003: 156)

In the course of a study that sought to develop observations first made by Fraser (2000) on the integration of forensic science into criminal investigations, Williams (2004) sought to outline the organisational determinants and correlates of the ways in which the work of crime scene examiners is (or is not) aligned with the work of other police staff. The research suggested that there exist two quite different understandings of what 'integration' means in this context. The first of these – 'structural integration' was largely concerned with establishing lines of authority over the work of crime scene examiners, and consisted largely of the construction of organisational arrangements in which such staff came under the direct control of local BCU police managers. An alternative – and opposing – understanding gave primacy to the 'procedural integration' of crime scene examination work into the overall investigative process. This latter version was sometimes viewed as the development of the 'investigatory element' contained within the work of examiners, but also informed the appointment of other staff to work alongside them in order to make the best use of their time, the artefacts and the information that they generate. It was this understanding of integration that was first voiced in *Using Forensic Science Effectively* (ACPO/FSS/Audit Commission 1996) and it has continued through to the most recent HMIC reports.

These different interpretations of 'routine integration', as 'structural' or 'procedural', reflect and reinforce more fundamental differences in the way that police managers interpret the nature and utility of scientific support to crime investigation. An emphasis on structural integration is reinforced by an interpretation of scientific support as the provision of *technical assistance to investigators*. On the other hand an emphasis on the importance of procedural integration derives from and supports an interpretation of scientific support as constituting *expert collaboration within investigations.* The former notion, that scientific support provides technical assistance to investigators, is a longstanding one visible in the early vocabulary of 'scientific aids' to policing, although surfacing in the contemporary era in a technological guise. Practitioners defined in this way are seen as having strictly delimited areas of competence and are required to provide technically reliable and valid information to be evaluated by other crime investigators. Whatever their level of expertise or

seniority within their own area, their work is carried out under the direction and supervision of those with a more central stake in crime investigation and detection.

On the other hand, an alternative 'expert collaboration' understanding of scientific support acknowledges the distinctive knowledge-based expertise of crime scene examiners and other forensic science staff. It is based on recognition of the relevance of this knowledge and the product of its routine application for the investigation of individual volume crimes, and furthermore it may incorporate the view that (at least some of) the users of the service are themselves insufficiently knowledgeable to offer informed assessments of its quality and its investigative potential. Features of this 'expert collaboration' model of integration are clearly visible in some recent reports and also reinforce what was earlier claimed by the authors of the *Murder Manual* (ACPO 1999) about the gains that result from organisational efforts to properly integrate forensic science within police responses to reported crime so that 'there is effective consideration of the potential for forensic science to contribute to the investigation and that all who can contribute are given the opportunity' (Fraser 2007: 397).[17]

Using forensic science: building the foundations of evidence-based practice

A number of UK government policy developments from the late 1990s to the present day (including the DTI Foresight Initiatives, the Police Reform Bill, and the Police and Home Office Science & Technology Strategy) provide evidence of the intensification and rationalisation of state commitment to the development of forensic science. These developments have both informed and been informed by research sponsored by three main stakeholders in this development – ACPO, the FSS, and various bodies within the Home Office. These stakeholders – singly and in combination – have carried out or commissioned almost all of the empirical studies of the uses of forensic science in support of criminal investigations carried out in the UK since the Royal Commission on Criminal Justice research studies in the early 1990s (Roberts and Willmore 1993; Steventon 1993).

The majority of these studies have focused on the work of forensic specialists within the police service and have largely considered the role of forensic information in routine police investigations (rather than the uses of forensic evidence in exceptional judicial deliberations).[18] Their approach has been further defined by the adoption of a common discursive repertoire which includes a developing terminology to represent the different actions and events that make up the 'forensic process' within investigations, and their use of increasingly standardised quantitative variables to measure individual and collective performance at different stages in this process. The development of this standardised vocabulary and its associated set of measured variables signals the commitment of such studies to support the capacity of the three relevant agencies in their pursuit of centrally determined policy objectives – in particular the control of crime – throughout their designated specific spheres

of activity. It is important to note that the findings of this kind of research have been used directly to influence the work of those who provide forensic services. A particularly conspicuous instance of this is provided by the publication of the ACPO/FSS (1996) guide to good practice 'Using Forensic Science Effectively' which was almost entirely based on research, discussed later in this chapter, undertaken by Tilley and Ford (1996).

Prior to the commissioning of most of these studies, however, the report of the accountants commissioned by the Home Office to review the organisation of scientific support in UK Police Forces (Touche Ross 1987) was the crucial determinant of the organisation and resourcing of forensic science support to policing. Its economic 'style of reasoning' instantiating what elsewhere has been described as 'a ragbag of techniques, models, analogies and recipes for action that are loosely bound up by their appeal to economic rationality' (Garland 2001: 190) has provided a framework to which almost all subsequent studies have felt it necessary to refer and, sometimes, adopt.

Touche Ross attributed the low levels of police confidence in forensic science in the mid-1980s to the failure of the Forensic Science Service to respond to the needs of the police. They paid particular attention to the FSS inability to produce analysis of an increased volume of forensic submissions in a relatively timely fashion. The team of accountants proposed that the solution to this problem was the introduction of market mechanisms and the principle of 'direct charging' so that individual police forces would approach suppliers (including, but not exclusively, the FSS) to agree prices for the type and volume of forensic analysis they required. It was argued that such mechanisms would allow the police, as consumers, to directly affect the quality and quantity of service they wanted in ways that were impossible when the Home Office directly controlled the FSS and when the police were not paying directly for work done on their behalf. Direct charging for forensic services to all police forces in England and Wales was introduced in 1991.

In addition to the first introduction of this first market (or quasi-market) for forensic services, the Touche Ross report also included several other recommendations for changes in the organisation of scientific support within police forces. The introduction and further effect of these changes provided a continuing focus of research for subsequent studies of the uses of forensic science within criminal investigations. Two particular recommendations were especially important.

The first was their argument for the appointment of senior staff in each police force with specific responsibility for the management of all forensic work undertaken within the force and for the commissioning of all forensic work undertaken by outside agencies. Initially designated universally as 'scientific support managers', these new post-holders (civilians in some forces, sworn officers in others) took financial and administrative charge of all relevant specialist services including crime scene examination, the force laboratory, fingerprint and photographic departments and forensic submission units. All research on police uses of forensic science since the early 1990s has been informed by an implicit or explicit recognition of the importance of the performance of this role for understanding the quality of the delivery of forensic support within UK policing in general, and differences in the effectiveness of different police forces in particular.

A second set of recommendations by Touche Ross called attention to the wide variation amongst forces in the staffing levels of crime scene examiners and corresponding variations in the proportions of criminal investigations (especially volume crime investigations) which were supported by the collection and interpretation of forensic evidence. Touche Ross presented these seemingly unplanned variations to argue for the need for Home Office direction in deciding the most effective staffing levels and in improving recruitment standards and training within this increasingly civilianised staff group. Subsequently the Home Office did provide some direction ('staffing levels should allow an average annual maximum of 600 cases per SOCO to allow time for satisfactory examination of scenes' – Tilley and Ford 1996), and recruitment and training standards were markedly improved. However, almost all subsequent research has continued to scrutinise the ways in which the work of this staff group necessarily shapes the essential initial stages of any investigation to which forensic science support may be relevant.

The first of a number of studies conducted in the decade following the delivery of the Touche Ross report (Saulsbury *et al.* 1994), was a joint project commissioned by the FSS and ACPO. The commission followed 'discussions in Autumn 1991 between the Forensic Science Service and the Crime Committee of the Association of Chief Police Officers who were both interested in making forensic evidence more effective and efficient' (Saulsbury *et al.* 1994: 1). Research focused on police views of the 'usefulness' of different kinds of commonly encountered forensic evidence, how decisions were made about the submission of such evidence for analysis, and the degree of police satisfaction with the quality of case-relevant information provided to them by FSS scientists. Structured interview data were collected between November 1992 and February 1993 from 320 post holders (including scenes of crime officers, scientific support managers, forensic submissions officers, senior investigating officers and others) in eight police forces.

The results of this research are difficult to interpret since key questions seem to have been both generalised and decontextualised. For example, the question 'In general, how useful are the following types of physical evidence in furthering an investigation?' was followed by a list of evidence types (including 'DNA analysis', 'Mechanical fit', 'shoe marks', 'other marks', 'body fluid grouping', 'blood distribution', etc.) which the respondent was required to rate as 'no value', 'limited usefulness', 'useful' or 'conclusive'. A project 'working group' (made up of a representative of the FSS and nine 'police officers familiar with the handling of physical evidence') were also asked to rate the importance of evidence types so that answers could be compared against each other and evaluated for their 'objective accuracy'. Yet such objective accuracy could only be severely impaired by a process that evaluated the usefulness of forensic activities outside of the context of specific investigations.

Methodological limitations notwithstanding, the research remains relevant in so far as it clearly showed the importance attributed by serving police officers and police forensic specialists (the project working group and all respondents interviewed), to DNA profiling. In fact unspecified 'DNA Analysis' was the only form of forensic evidence that was rated conclusive by

a majority (90 per cent) of respondents (although fingerprints were not included amongst the list of evidence types offered in the interview). Despite these shortcomings the report is important for the way it instantiated a number of key themes which continue to inform subsequent research in this area: the lack of recognition given to the specialist knowledge and skills of crime scene examiners; low levels of satisfaction with the turnaround times for services provided by forensic laboratories and information provided by those laboratories; and concerns about the cost of forensic services since the introduction of direct charging regimes.

Prior to the publication of the final report by Saulsbury *et al.*, the Police Research Group of the Home Office, ACPO and the FSS had already established a joint project to 'examine and evaluate police uses of forensic science, and . . . to assess the extent to which police needs are being met by current forensic science provision' (Tilley and Ford 1996: v). Two forensic scientists from the FSS and two serving police officers each worked full time for one year (as members of the research team) alongside a Home Office nominee from the Police Research Group and a distinguished external academic consultant with a history of research on the police to produce a substantial study of forensic science.

The 'Tilley and Ford' study was initially piloted in two forces and fieldwork for the full research was carried out in 12 forces between July 1994 and June 1995. The report of the study offered a rather discouraging account of the organisation and use of forensic science support to crime investigation, especially to the investigation of volume crime, some years after the implementation of the Touche Ross reforms in the late 1980s and early 1990s. ('If the tone of this report appears negative, this is in part because many matters of concern were identified' – Tilley and Ford 1996: 46.)

Tilley and Ford asserted that the uses of forensic science remained essentially reactive, focusing on individual cases, rather than being integrated into wider policing as elements of crime investigation. More worryingly, Tilley and Ford reported a 'widespread lack of awareness within the police service about forensic science itself and what various tests can do'. Furthermore, they argued that, whilst they could generate no data of their own to measure the cost-effectiveness or 'investigative cost-benefit potential' of existing patterns of the use of forensic science, they dismissed available methods used by forces to determine effectiveness as having 'dubious reliability or validity' (Tilley and Ford 1996: 46–7).

In fact, while the report contains data on crime scene attendance levels amongst forces, as well as information about the number of (undifferentiated) items sent for forensic examination in support of the investigation of different kinds of crime in each of the forces studied, it does not provide detailed accounts of the frequency with which specific types of contact trace material are collected, analysed or used within forces (with the exception of fingerprint marks). Instead, such data that were already being collected by the forces in the sample (following recommendations of the Police Requirements Support Unit 1991) were separately analysed by another member of the Home Office Police Research Group and published simultaneously in a different series of Home Office Research Papers (McCulloch 1996).

This second study ('initiated to assist' the related work of Tilley and Ford) focused very directly on the Touche Ross recommendations (already endorsed and elaborated by the Audit Commission 1990) for the collection by individual forces of annual statistics 'on scene examination, fingerprints, forensic science and photography' (McCulloch 1996: 1), and the analysis and reporting of these differences between forces by an unspecified 'central body'.

Even though McCulloch's work largely used routine data captured by each force in the sample by the use of a common computer package, she reported severe technical difficulties in assembling a strictly comparable set of data from the forces in her sample. Comments similar to those found throughout the work of Tilley and Ford (1996) recur in this report in the form of requests for the provision of better quality and more rigorously standardised data. Despite these shortcomings, however, the available data (for the calendar year 1994) do permit the identification of some interesting patterns of forensic evidence collection and analysis in a range of crime investigations across the 12 forces studied.

Forces showed considerable variation in the proportions of forensic submissions (excluding fingerprint marks which are not normally the subject of 'forensic submissions' since they are separately submitted for examination to each force's own fingerprint bureau) made for different types of crime. Whilst 'those with a high crime rate tend to make forensic submissions for a large proportion of their violent crimes . . . [and] those with a low crime rate tend to make submissions for a high proportion of their burglaries' (McCulloch 1996: 35), concerns with the quality of the data made McCulloch reluctant to draw too many conclusions from these kinds of overall difference.

Data on the (then) relatively novel technology of DNA profiling are found in various places and in a variety of forms throughout the report. In one table (Table 6) they are shown to comprise only 5 per cent of all forensic submissions at that time, with documents, glass, fibres and footwear all being more numerically significant than this form of biological evidence (although the table is unhelpful since alongside 'DNA' it also separately lists 'semen', 'body tissue' and 'saliva' as being submitted for examination). Another table (Table 7) which displays the proportion of DNA tests accounted for by four main offence categories shows that 40 per cent of DNA submissions were made as part of the investigation of sexual offences, 32 per cent were made in connection to the investigation of murder and suspicious death, and 20 per cent were made in support of assault investigations. The investigation of burglary in 1994 occasioned only 2 per cent of DNA submissions in the 12 forces studied. Most forces used DNA testing in about 1 per cent of cases overall; two forces did not use DNA testing for burglary scenes whilst the highest using force made 9 per cent of its DNA submissions in relation to burglary investigations.

An important aim of McCulloch's study was to examine available data on police evaluations of the usefulness of different forensic items collected from the crime scene and submitted for analysis. The guidelines followed by each force for data entry to the relevant computer system expected both Officers in the Case (OICs) and Scientific Support Managers (SSMs) to evaluate the usefulness of each forensic submission made. The OICs were required to use

a four-point scale representing the degree to which the test was 'useful to the case' ('Very useful', 'Useful', 'Limited use' and 'No value') while SSMs used a four-point scale which evaluated the 'scientific value' of each test ('Conclusive', 'Strong', 'Some evidence which identifies or eliminates a suspect' and 'No evidential value'). Surprisingly large amounts of these evaluative data were never completed by relevant police staff in the forces studied (OICs completed only 30 per cent of such evaluations while SSMs completed 83 per cent of them).

The studies by Tilley and Ford and McCulloch provided the most detailed and systematic examinations of the uses made of forensic information and expertise within the police service in the last decade of the twentieth century. Yet the studies were limited in their analysis of the professional and organisational factors that shaped the uses made of the results provided by particular forensic technologies. Such a shortcoming was, they insisted, the result of the poor quality of police data available to their research.

Nevertheless, this body of research (in particular that carried out by Tilley and Ford) provided the first generally accepted understanding of the 'forensic process' in UK crime investigation. Moreover, the multi-agency project, of which the research was only one element, made use of the essentially negative findings of the two studies to reinforce arguments about the necessity for wholesale improvements in current standards in the collection and utilisation of forensic information for intelligence and evidential purposes. This was done through the publication of *Using Forensic Science Effectively* (ACPO/FSS/Audit Commission 1996) which sought to provide new guidelines and was widely disseminated amongst forces and received strong support from relevant senior staff in the FSS and ACPO. In so far as it identified and promoted examples of 'best practice' it also served as a promissory note to government, indicating what could be achieved by those police forces who were fully competent in the deployment of a quickly expanding repertoire of forensic technologies.

Whilst the fieldwork for these studies was largely carried out before the explosion of state support for DNA analysis and databasing contributed to changes in the circumstances within which analytical work was carried out within forensic laboratories, Tilley and Ford did make specific mention of this development. They reported that a number of forces had expressed concerns about the costs of DNA profiling and databasing and that 'there are widely varying estimates of the proportion of scenes which will yield stains susceptible to DNA profiling' (1996: 42). It is clear from remarks elsewhere in the report that they expected some changes in the uses of forensic science and that the rapid development of DNA profiling would contribute to those changes. However, they provide no detailed speculation, instead asserting that: 'What the future holds for forensic science is not clear. In particular the development of a national DNA database may have a strong influence on patterns of usage. In the longer term it might have an impact on more traditional forms of forensic analysis' (1996: vi). In hindsight, their assessment of the significance of the advent of DNA profiling for the wider standing of forensic science and its place in the criminal justice system may seem overly modest.

Soon after the National DNA Database was established in 1995, large claims began to be made about the changes brought about by its introduction. For

instance, Dave Werrett Chief Scientist of the FSS at the time asserted that 'there are now more stains analysed from undetected crime scenes than there are stains analysed within normal casework procedure' (Werrett and Sparkes 1998: 58). Whilst one force studied earlier by McCulloch (1996: 11) had a submission policy which specified that 'evidence from burglaries is only sent to the lab if there is a known suspect' such patterns of submission were already being characterised as outdated, and were quickly being replaced by a radical new kind of forensic work:

> Traditionally forensic science has been part of a supply chain: samples would be obtained from scenes and suspects, some information with regard to the offence would be supplied to the laboratory. The laboratory would carry out examinations, a report would be produced that would go the Prosecution Service, or indeed the Defence, and finally where appropriate a court case would ensue. Through information being provided by the DNA Database the laboratory is now instigating investigations. Inceptive intelligence information produced by the National DNA Database is leading to new forms of crime investigation that are now becoming integrated within police procedures in the UK. (Werrett and Sparkes 1998: 58)

Whilst a series of evaluative studies of the effectiveness of recent administrative and technical innovations in scientific support to policing has been carried out in the last 10 years these studies have largely been disseminated amongst a small body of researchers and some have remained confidential until very recently. Most have focused attention on the collection and analysis of a restricted range of contact trace material regularly recovered at crime scenes, and developments in the collection and use of DNA evidence since the establishment of the database in 1995 have provided a central focus of many of these studies. They have also shared an underlying commitment to the development of improved measures of performance outputs and outcomes as part of their attempt to construct a model of the contribution of more varied forensic information to the detection, prosecution and reduction of volume crime (see e.g. McCulloch and Tilley 2000; Burrow *et al.* 2005b). This 'attrition model'[19] of the forensic process encourages the collection and analysis of data showing the proportion of recorded crime scenes attended, the proportion of scenes attended from which forensic artefacts are recovered, the proportion of these artefacts that facilitated the identification of suspects or linked scenes, and the proportion of such identifications that led to detections. Especially detailed results of its application in the collection and analysis of DNA evidence are available in Burrows *et al.* (2005a). Barrow (2005) and Green (2007) also provide attrition data relating to DNA profiles, fingermark and footwear mark collection, comparison and use, with Rix (2004) focusing particularly on the latter technology. Finally, a systematic effort to apply the model to the whole forensic process has informed work undertaken for the Home Office by a private company – Lanner Group Ltd. The work led to the introduction of management software (Scientific Work Improvement Package) available to all forces in England and Wales, but at the time of writing, the

Home Office report which evaluated this resource remains restricted in its circulation.

In addition to commissioning these studies, key government agencies and Parliamentary bodies have also carried out a series of major reviews of forensic science (e.g. House of Commons Home Office Affairs Committee 1989; Audit Commission 1993; House of Lords Select Committee on Science and Technology 1993; HMIC Thematic Inspection Reports 2000, 2002a,b; House of Commons Science and Technology Committee 2005).[20] These reviews generally have commended the willingness of police forces to 'harness the power of science to beat crime' (Home Office 1999), but they have often been critical of aspects of the delivery, organisation and monitoring of such scientific support. For example, David Blakey (HMIC 2000) was especially forthright in his criticism of**:** weaknesses in the professional and strategic exploitation of the use of forensic science for crime investigation in general; the variable – and sometimes inadequate – quality of forensic leadership, advocacy and awareness at a number of levels within police forces; the poorly organised deployment and use of crime scene examiners; and the 'paucity, questionable quality and accuracy of performance data' within the area of scientific support.

The approach taken by HMIC and other Home Office actors has been strongly influenced by developments in the public services in general in which increasingly rigorous (and imaginative) efforts have informed the development of indicators of the efficiency and effectiveness (including cost-effectiveness) of a variety of forms of service provision. At the beginning of this century, the government's crime reduction strategy (Home Office 2000) explicitly commended the beneficial results of the introduction of performance league tables and regular monitoring of performance in the health service and in education and looked forward to the results expected to derived from the enhanced application of such approaches to the field of policing. The later introduction of 'Best Value' considerations into policing provided a powerful statutory framework for consideration of target setting within police authorities, and scientific support staff are subject to this overall framework. The orientation of senior management to such a framework in turn ensures that measures of labour effort and labour output of scientific support staff are considered alongside the effort and output of other staff groups in contemporary discussions of police performance and its overall outcome.

Attention to these issues is unquestionably legitimate, and where properly understood and managed, will be positive both for the attainment of overall organisational aims and for the everyday work of employees. However, enthusiasm for the constant monitoring of individual staff performance by reference to currently available performance indicators needs to be tempered by the acknowledgement both of a number of shortcomings in the current repertoire of indicators and of the unintended consequences that can arise when individual staff members treat such performance criteria as a guide for their actions. Ericson (1981: 67) cites Etzioni and Silverman when indicating the potential for 'organisational drift into areas that are measurable, resulting in over-production in measurable areas and neglect of the less measurable'. Although this comment was made more than 25 years ago, it remains germane to an understanding of the current situation in a number of organisations.

Some of these issues include: the diminution of professional autonomy in task performance; a neglect of the contribution to individual performance made by differing forms of collective effort; and the resource dependency of individual levels of measured performance.

Forensic science and intelligence led policing

The warmth of the police embrace of forensic science reflects their confidence that a particular body of scientific knowledge and repertoire of technological devices can be used to support unequivocal and authoritative accounts of criminal actions and criminal identities. However, not all of these accounts will be tested in the way they might be when forensic material is subject to judicial and lay evaluation in courtroom settings. Many more are used as 'forensic intelligence', in other words as information used to further direct ongoing criminal investigations and disruptions, rather than as props in the dramaturgy of a criminal trial.

In the last decade of the twentieth century, an important Audit Commission Report on the standard of criminal investigations in England and Wales (Audit Commission 1993) strongly endorsed 'intelligence-led policing' as a relatively novel 'proactive' approach to law enforcement and crime control. Since that time, this approach has become an essential feature of contemporary policing practice (see e.g. Gill 1998; John and McGuire 2003; Tilley 2003), the main elements of which include: the targeting of known active offenders; the management of crime and disorder 'hotspots'; the investigation of linkages between crimes and the emergence of crime series; and the application of 'partnership preventative' measures. Nowadays each of these elements needs to be supported by the provision of an evidence base of 'criminal intelligence', a term which is often defined rather loosely, but which generally refers to 'information that has been interpreted and analyzed in order to inform future actions of social control against an identified target' (Innes *et al.* 2005: 42).

The growth of specialised 'intelligence units' to gather, evaluate, co-ordinate, analyse and disseminate such information within police forces (see Tilley 2003; Cope, this volume) has required, and in turn encouraged, the development of new technological systems which facilitate the recording and interrogation of increasingly varied types of information held by the police and other state agencies. It is an acknowledged feature of policing in general and this mode of policing in particular, that its effectiveness is hugely dependent on the existence of a comprehensive 'organisational memory' (see Marx 1988; Innes *et al.* 2005) containing various kinds of crime-relevant information, and whose construction, growth, maintenance and dissemination are all reliant on computer-based technologies of storage and communication. Whilst the development and deployment of intelligence is merely one demand made of such organisational memories, the willingness to meet this particular demand is targeted at improving knowledge about, and more effective intervention into, criminal activities. In particular the determination of where, how, when, why, and against whom, action should be taken.

The National Intelligence Model (NIM), developed by the National Criminal Intelligence Service and adopted by ACPO in 2000, has provided a new vocabulary for shaping the details of this new approach to crime control, and the National Policing Plan 2005–2008 describes the NIM as a 'cornerstone' of policing in England and Wales (see Maguire, this volume). The purpose of the NIM is to ensure that all potentially useful information is fully researched, developed and analysed to produce intelligence capable of providing both strategic and tactical direction to police investigations. The NIM is a technologically supported instrument designed to improve investigative efficiency, increase detections, and contribute to crime reduction by structuring the collection, development and uses of intelligence to target individual offenders (and potential offenders). 'Key assets' for its effective use are described as being: available and exploitable sources of intelligence; identifiable intelligence roles and the knowledge required to carry them out; and the facilities and access necessary to carry out those roles. Accordingly, its adoption across England and Wales has, in turn, led to increased consideration of information and communication technologies – both hardware and software – to condition what can count as intelligence data, shape how it should be collated and interpreted and consider how recommendations for action may be developed from its analysis (see e.g. Gill 2000; Maguire 2000; NCIS 2000; Cope 2003; John and Maguire 2003; Tilley 2003).

Neither the original Audit Commission report, nor the subsequent development of the NIM, paid any particular attention to the potential contribution of forensic science to the emerging model of intelligence-led policing. This is a puzzling oversight, since as Innes *et al.* (2005) point out, strong linkages exist between the ambitions of criminalistics and forensic science on the one hand, and those of technologies of crime analysis on the other hand (see also Rose 1999, 2000a). In addition, recent work by others (see especially Ribaux and Margot 1999, 2003; Ribaux *et al.* 2003; Ribaux *et al.* 2006), has suggested the potential fruitfulness of this integration, and these studies have argued strongly that what are currently distinct forensic science and intelligence communities would both profit from sharing – with each other and with investigators – their differing forms of specialist knowledge.

That is not to say that individual police forces have failed to consider, at least in general terms, the relationship between the new orthodoxy of intelligence-led policing and the parallel increased enthusiasm for forensic science support to policing. However, the development of this relationship has not always been satisfactory since it has usually amounted to the inclusion within, or establishment alongside, existing crime analysis systems of a limited selection from the total information and evidence collected by crime scene investigators during their scene attendance. In this way, whilst some vague notion of 'forensic intelligence', has often come to be located within the larger organisational memories of most police forces, there remain many differences in the ways in which individual forces (and sometimes BCUs within forces) have sought to record, process, and communicate the varying amounts and kinds of information stored in such memories.

In general there is no systematic knowledge of what methods of defining, collecting, recording, processing and using forensic intelligence, work most

effectively. Particular forces may introduce innovations, which seem initially to be successful, and these are sometimes taken up more widely, but their proliferation is often accompanied by changes in the details of their implementation, or the enthusiasm with which secondary users greet their arrival. These considerations often mean that what has seemed to work well in one context has worked less well in another, and so the trajectories of their adoption (and subsequent routine incorporation or abandonment) vary considerably. Underlying these variations are more fundamental issues that concern the extent to which various stakeholders appreciate the differing kinds of expert knowledge and associated vocabularies that are typically utilised in forms of crime analysis on the one hand, and in forensic examination on the other hand.

The introduction of the Home Office 'Forensic Integration Strategy' (FIS) provided a significant opportunity to consider these matters in much more detail. The strategy was described as an 'investment fund to enable existing police resources to be used more efficiently' and also as 'a catalyst for modernisation'. It was established on 1 April 2005 and superseded the DNA Expansion Programme (which is subsumed in the larger strategy). The overall aim of the FIS was 'to ensure that by March 2008 the police optimize their use of forensic science, extending the UK's global lead on the use of DNA to all forms of forensic intelligence' (Forensic Science and Pathology Unit 2005: 27). It was predicated on the observations that there is insufficient integration of different kinds of forensic data, and that lessons learned from the successful development of DNA profiling and databasing should be applied more widely. The strategy had a number of relatively general objectives, amongst which were to 'deliver more, faster, better forensic support and intelligence at lower cost'; 'standardise and optimise techniques and processes'; and 'integrate different types of forensic data' (Home Office 2005: 12). Fereday (2004: 12) suggested that the FIS was focused not only on the integration of different types of forensic intelligence with one another but also the integration of these types of intelligence 'with the National Intelligence Model processes and products, and with broader criminal intelligence at Basic Command Unit, force and national levels', as one part of this would 'look at working practices and expectations of non-forensic specialists within police forces'. At its simplest level, the FIS sought to bring together existing and potential forensic databases (such as DNA, fingerprints, ballistics, shoemarks, etc.) with 'broader criminal intelligence on offenders and offences (such as criminal careers, known associates, methods of offending and patterns of crime)' (Fereday 2004: 12). However, following the establishment of the National Policing Improvement Agency and its early review of the activities for which it assumed responsibility (including the strategic view of forensic science), this strategic framework has undergone revision at the time of writing and the details of the new framework are not yet publicly available.

An international dimension

The desire to foster and expand the pan-European sharing of forensic intelligence is a longstanding feature of both EU politics and policing. This is

one element in an increasingly sophisticated network of intelligence gathering across the EU which has been described as driven by a 'transnational police elite' who have 'come to form part of an opaque, thinly accountable policy network increasingly organized around an ideology of *European* security' (Loader 2004: 57, emphasis in original; see also, Walker, this volume). It is, of course, the recurrent political concern with EU security which underpins the justification for collecting and maintaining large archives of data that are independent of national policing authorities. Yet, 'security' is a contestable term and there has been no systematic consideration by the Council, Commission or Parliament of the EU of the usefulness of using forensic intelligence in relation to either national security or law enforcement.[21]

The legal basis upon which police forces in criminal jurisdictions across the EU exchange intelligence data has been developed through both the Maastricht Treaty (1992) and subsequently through the Treaty of Amsterdam (in force, 1999). Title VI of Maastricht created the Third Pillar of the EU, 'Justice and Home Affairs', which allowed for a number of cross-border operational activities between police forces for the purpose of preventing and detecting crimes (these are outlined in articles 29–42, 'Provisions on Police and Judicial Cooperation in Criminal Matters'). It was through this treaty that the European Police Office (Europol) was established (although it did not become fully operational until 1999). However, because Title VI was modelled on pre-existing intergovernmental modes of co-operation (which were themselves the remnants of previous European agreements) it faced a number of criticisms, most notably that it enabled non-harmonised, over-complicated and non-transparent co-operation whilst affording EU institutions no effective way of exercising control over member states' decisions (see Apap 2002). The Treaty of Amsterdam, which reformulated the Third Pillar and brought into being the Area of Freedom, Security and Justice, was a response to this.

Since the Treaty of Amsterdam came into force, the EU has grown considerably, expanding both its external borders and its internal land mass and population. With the development and implementation of the Schengen acquis, coupled with the renewed emphasis on the threat of terrorism, the EU has developed a new 'security discourse' (Walker 2002) focusing on both its frontiers and its internal territory. A central part of this continually developing culture of EU securitisation is the emphasis on increasing and making more efficient intelligence exchange between the police forces of the 27 EU states as well as strengthening the role of transnational policing. Such co-operation has been encouraged through the Schengen Information System (SIS) which was developed as an instrument for exchanging information between nation-states that now permitted greater flows of movement of persons across their borders. The SIS comprises a computerised network which allows all police stations and consular agents from Schengen group member states to access data on specific individuals, vehicles and property. Member states provide information through national networks which are connected to a central system.

The SIS is an example of a formal mechanism designed to facilitate the exchange of intelligence between member states. Yet since 1994 and a draft framework published by the Multidisciplinary Group on Organized Crime at the Council of the European Union, there has been a demand for the overhaul

of existing systems for exchanging information.[22] The framework argued that 'effective and expeditious exchange of information and intelligence between law enforcement authorities is seriously hampered by formal procedures, administrative structures and legal obstacles laid down by Member States' legislation' and that, whilst the framework does not 'purport to change these systems', this is a 'deficiency that will have to be remedied'.[23] The framework – later embodied in the Hague 'Principle of Availability' proposed to remedy the current systems for intelligence exchange by creating a common set of conditions through which Member States can request intelligence from any national EU law enforcement agency.

The framework recommended a series of procedures to simplify the exchange of intelligence between member states in relation to the gathering of information regarding criminal activities and suggested that the exchange of intelligence should be processed through the widest possible set of channels. Some such channels exist already but the framework stressed that, whereas current data-sharing is constrained by the legal differences of member states, a 'horizontal' approach should be adopted. The recent adoption of the Prüm Treaty by a number of EU states is the harbinger of what such a 'horizontal approach' may mean for the future of forensic intelligence exchange across the EU.

However, the exchange of fingerprints, DNA profiles and vehicle registration data now facilitated by the Prüm Treaty raises a number of important issues that will form the basis for future debate over the internationalisation of forensic intelligence exchange. First, the continued international exchange of such data – especially DNA data – in a context which is characterised by the absence of any formal EU governance raises a number of questions about data protection and security.[24] Second, the vast differences in member states' legislative and procedural provision for obtaining and storing fingerprints and DNA contrast with the current lack of any formal mechanism for governing and monitoring the scope of supranational databasing by Europol and Interpol. Third, the political emphasis and commitment to constructing national fingerprint and DNA databases in each member state remains varied and, in some countries, unrealised.

Conclusion

In the course of this chapter I have suggested that crime scene examination in particular, and forensic science support to policing in general, should be understood as the effort accountably to discern, through the rigorous examination and retention of physical traces and other information, the course of crime relevant actions and events. Other actors are able to use these material and cognitive resources to contribute to a very wide range of matters relevant to criminal investigations, and whilst it is impossible to catalogue all of those benefits here, at least they include robust support to establish that: a particular offence has taken place; particular actions have taken place at a scene; individuals with a range of unique characteristics have been present in particular parts of a crime scene; individuals possessing a range of character-

istics with a known frequency have been present in particular parts of a crime scene; individuals possessing one of a range of 'class' characteristics have been present in particular parts of a crime scene; particular instruments have been uses at a scene, and in some cases used by identifiable individuals; and there are 'links' between a number of different crime scenes.

All of these – and other - forensic accomplishments can be used to direct subsequent investigatory effort (including the inculpation or exculpation of specific suspects, the structuring of interviews with witnesses, victims or suspects) as well as inform subsequent case-making against persons charged with criminal offences. It almost goes without saying that, wherever possible, the assembly of such evidence and information has to meet the exacting standards required for presentation and justification in judicial settings. Uncontrolled features of physical trace evidence and the circumstances of its discovery means that such standards cannot always be met, but even when they are not, important and useable intelligence may still result.

The development of a small group of specialist scene examiners (making up less than 2 per cent of the total police labour force) to undertake this work has left trained detectives free to specialise in other aspects of the investigative process. However, this necessary specialisation of tasks can lead to poor levels of understanding of the potential of forensic science and an accompanying unwillingness to recognise the nature and extent of its usefulness in specific cases. Therefore, central to the successful use of forensic science support is the integration of crime scene examiners (as the major providers of such support) into the investigative process. Over the past 10 years a number of studies have asserted that, despite strong suggestions from key actors, crime scene examiners are still not always adequately integrated with police officers within recognised investigative teams (e.g. McCulloch 1996; Tilley and Ford 1996; HMIC 2000; Smith and Flanagan 2000; Williams 2004).

In the absence of such integration, the application of individual or group performance monitoring will not necessarily be effective in enhancing the quality of the work carried out by such crime scene examiners, nor in improving the effective uses made of this work by other criminal investigators. Closer monitoring is not a substitute for rigorous research on the process of crime scene examination in particular or on the application of forensic science and its associated technologies in general. At the moment key UK agencies show little enthusiasm for such research, yet in its absence it is difficult to see how it will be possible to 'move forensic science to centre-stage so that it is part of [police] service delivery at a strategic level' (Green 2007: 354). There is no sign that this situation will be improved in the newly privatised world of forensic science provision, and in fact, the opposite might be true. At the same time, the increased UK interest in evidence-based policing may find attractive the kinds of studies that are now beginning to emerge elsewhere in the world, in which carefully designed and executed 'field trials' offer new insights into what the benefits – and cost effectiveness – of specific forensic interventions[25] may be. It will be interesting to see whether ACPO, the Forensic Regulator and other key actors are willing to embrace, or even fund, the development of this new kind of forensic science knowledge.

Notes

1 For the purposes of this chapter, the term 'forensic science' refers generally to the application of scientific knowledge and technology to the administration of criminal and civil justice matters. Typical forensic science disciplines include: toolmark and fingerpint comparison; firearms and ballistics analysis; a variety of forms of DNA profiling; hair, fibre, glass, paint and soil analysis; footwear and tyre impression comparison; blood spatter analysis; and a range of techniques for the analysis of 'questioned documents'.
2 An expert group of the US National Academy of Sciences 'Board on Mathematical Sciences and Their Applications Committee on Science, Technology and Law' is deliberating some of these issues currently. Progress on their project 'Identifying the Needs of the Forensic Sciences Community' can be viewed at: http: // www8.nationalacademies.org/cp/projectview.aspx?key=48741.
3 However, they are taken up in several chapters of Fraser and Williams (forthcoming). See also, Broeders (2007).
4 There are of course other such sites of operation, most especially the 'forensic laboratory' but they will not be the focus of this chapter. For other comments on sites of operation and their relationship to sites of deliberation relevant to forensic science, see Williams and Johnson (2006).
5 The concept of the 'crime scene', or the 'crime scene paradigm' is the 'the central source and reference point for analysis of the many legal issues that are involved directly or indirectly in the field of forensic evidence' (Kiely 2006: 27).
6 Green (2007: 342) reports that 4,490 individuals were employed in forensic science posts in the 43 police forces in England and Wales during the financial year ending in April 2005. Almost exactly one half of these were working as crime scene examiners.
7 Signs are emerging that some larger police forces may respond to the recent marketisation of forensic science (in particular the changed status of the Forensic Science Service) by expanding their own laboratory-based forensic specialist capabilities in specific areas.
8 For an account of the forensic science support available to investigators in this period, see Else and Garrow (1934).
9 Osterburg and Ward (2000) remind us that there are two kinds of photographs that may be taken: first, a photographic representation of the overall scene, photographs of relevant scenic details and those showing the location of physical evidence; second, a photographic record of details used for scene reconstruction and identity establishment. Some criminalistic texts argue for the necessity of always photographing a fingerprint in situ before lifting it as well as preserving any objects which bear relevant fingerprints. Certainly where the origins of a print might be contested in court then a photograph of its original location will remove doubt about its origins, although it seems that such evidence is not often contested – certainly in the case of volume crime.
10 The American Academy of Forensic Sciences defines criminalistics as 'that profession and scientific discipline directed to the recognition, identification, individualization and evaluation of physical evidence by application of the physical sciences to law-science matters' (quoted in Nickell and Fischer 1999: 2).
11 See, for example, Osterburg and Ward's suggestion that: 'Unfortunately, for a variety of reasons, crime scene searches are conducted in only a few cases ... Research indicates that most crime scenes contain much more physical evidence than is discovered' (2000: 523).
12 See, for example, the Forensic Science Service's *Scenes of Crime Handbook* and their 'Critical Success Factor' forms. In addition, most police force scientific support

departments also issue their own handbooks and specify search and seizure protocols which they expect crime scene examiners to use to direct their operational work.

13 For, example, in burglary cases it is conventional to argue that points of entry to and exit from the property deserve the most detailed examination: 'these areas will embody the largest reservoir of potential evidence for investigators' (Lyman 1999: 73).

14 What has destabilised this understanding, of course, is the success of the National DNA Database in developing the inceptive uses of forensic science, success that may also be mirrored in the increasing use of the National Automated Fingerprint Identification System (see Williams and Johnson 2007, 2008; National DNA Database 2007).

15 The selectivity of detectives' recollections of the detailed course of crime investigations (where more objective records are not available) remains an issue in more recent attempts to collect reliable data on the use made of forensic information by investigators.

16 A study of the skills of effective Senior Investigating Officers by Smith and Flanagan (2000) also provided an insight into the investigative process in cases of serious crime. Experienced officers interviewed in the course of this study emphasised the importance of SIOs' initial assessment of a crime scene as well as their capacity for evaluating the work of individual specialist staff (including scene examiners and forensic scientists). However, the researchers did not invite SIOs to comment on the relative value attached to the different kinds of information (including forensic information) that might be forthcoming in the course of criminal investigations – perhaps because of the shifting circumstantial details that are thought to determine such values in individual cases. Furthermore, the study provides no description of SIO's understandings of the role of scientific support except where the authors comment that SIOs thought it essential to facilitate 'close collaboration with relevant personnel (e.g. Scenes of Crime Officers, forensic scientists and the pathologist)' (Smith and Flanagan 2000: 20).

17 Prior to the two 1993 Royal Commission research studies, only two published monographs had offered any relevant analysis of forensic science within policing. The first was a study of police investigative procedure which suggested that physical evidence collected at crime scenes very rarely resulted in the identification of a criminal suspect (Steer 1980). The second was a study of the work of the Forensic Science Service carried out in the mid-1980s in which the role of physical evidence was seen to be discouragingly slight and its potential largely ignored by the police unless more traditional forms of evidence were unavailable. This report suggested that, even when such evidence was collected and analysed, there remained a large gulf of (mis)understanding between forensic scientists and police investigators (Ramsey 1987).

18 For a more detailed review of research on the uses of forensic science in support of volume crime investigation, see Bradbury and Feist (2005).

19 See Burrows *et al.* (2005a).

20 In addition to these Thematic Inspections, regular HMIC Police Force and Basic Command Unit (BCU) inspections have reported and interpreted a corpus of comparative data on scientific support activity as part of their more general evaluations of force and divisional performance (see HMIC 2002b for a summary statement of emerging findings from the first round of BCU reports).

21 More detailed accounts of many of the issues discussed in this section may be found in Johnson and Williams (2007), Wilson (forthcoming) and Home Office (2005).

22 Council of the European Union 'Draft Framework Decision on simplifying the exchange of information and intelligence between law enforcement authorities of

the member States of the European Union, in particular as regards serious offences including terrorist acts' 13869/04.

23 Council of the European Union 'Draft Framework Decision on simplifying the exchange of information and intelligence between law enforcement authorities of the member States of the European Union, in particular as regards serious offences including terrorist acts' 13869/04.

24 See, for example, European Data Protection Supervisor (2006a,b) and House of Lords European Union Committee (2007).

25 See, for example, Roman *et al.* (2008).

This chapter includes work originally carried out in collaboration with Paul Johnson on our Welcome Trust fund project 'Forensic DNA Databasing: A European Perspective' [GR 073520].

Selected further reading

The current condition of forensic science in England and Wales is fully explored in the House of Commons Science and Technology Committee Report *Forensic Science on Trial* published in 2005. McCartney (2006) *Forensic Identification and Criminal Justice: Forensic Science, Justice and Risk* also provides a useful critical historical account of forensic identification and its uses in contemporary society. Townley and Ede (2004) *Forensic Practice in Criminal Cases*, is an authoritative source of information on legal and technical aspects of police and laboratory forensic practice, and both Roberts and Zuckerman (2004) *Criminal Evidence*, and Redmayne (2001) *Expert Evidence and Criminal Justice*, offer valuable guides to the uses of forensic science in support of criminal prosecutions. Texts which provide introductions to technical features of forensic science include White (ed.) (1999) *Crime Scene to Court: The Essentials of Forensic Science* and Jackson and Jackson (2004) *Forensic Science*. More theoeretical issues are dealt with by Inman and Rudin (2001) *Principles and Practice of Criminalistics: The Profession of Forensic Science* and by the many contributors to *Science in the Law: Forensic Science Issues* edited by Faigman *et al.* (2002).

A readable and more general treatment of these issues (which includes interviews with key actors in the US) is Pyrek (2007) *Forensic Science under Seige: The Challenges of Forensic Laboratories and the Medico-Legal System*. The UK policy and operational issues discussed in the chapter are also explored by Bradbury and Feist (2005) *The Use of Forensic Science in Volume Crime Investigations: A Review of the Literature* and by several chapters in Part 3 of Newburn *et al.* (eds) (2007) *Handbook of Criminal Investigation*. Finally, policy and ethical issues surrounding the use of forensic science, especially forensic genetics are discussed in Williams and Johnson (2008) *Genetic Policing: The Use of DNA in Criminal Investigations*, in a collection of papers edited by David Lazer (2004) *DNA and the Criminal Justice System: The Technology of Justice*, and in the recently published (2007) report of the Nuffield Council on Bioethics *The Forensic Uses of Bioinformation*.

References

Adderley, R. and Bond, J. W. (2008) 'The effects of deprivation on the time spent examining crime scenes and the recovery of DNA and fingerprints', *Journal of Forensic Sciences*, 53: 178–82.

ACPO (1999) *The Murder Manual*. London: Association of Chief Police Officers.

ACPO (2005) *DNA Good Practice Manual*. London: Association of Chief Police Officers.
ACPO/FSS/Audit Commission (1996) *Using Forensic Science Effectively*. London: HMSO.
Apap, J. (2002) 'Transfer of competence: between sovereignty and supranationality', in M. Anderson and J. Apap (eds) *Police and Justice Co-operation and the New European Borders*. The Hague: Kluwer Law International.
Audit Commission (1993) *Helping With Enquiries; Tackling Crime Effectively*. London: HMSO.
Barrow, K. (2005) *Study into Intelligence Packages*. London: Home Office
Bond, J.W. (2007a) 'Value of DNA evidence in detecting crime', *Journal of Forensic Sciences*, 52: 128–36.
Bond, J.W. (2007b) 'Maximising the opportunities to detect domestic burglary with DNA and fingerprints', *International Journal of Police Science and Management*, 9: 287–98.
Bond, J.W. and Hammond, C. (2008) 'The value of DNA material recovered from crime scenes', *Journal of Forensic Sciences*, 53: 797–801.
Bradbury, S.A. and Feist, A. (2005) *The Use of Forensic Science in Volume Crime Investigations: A Review of the Literature*. London: Home Office.
Broeders, A.P.A. (2007) ' Principles of forensic identification science', in T. Newburn, T. Williamson and A. Wright (eds) *Handbook of Criminal Investigation*. Cullompton: Willan, 303–37.
Burrows, J., Hopkins, M., Hubbard, R., Robinson, A., Speed, M. and Tilley, N. (2005a) *Understanding the Attrition Process in Volume Crime Investigations*. London: Home Office.
Burrows, J., Tarling, R., Mackie, A., Poole, H. and Hodgson B. (2005b) *Forensic Science Pathfinder Project: Evaluating Increased Forensic Activity in Two English Police Forces*. London: Home Office.
Cole, S.A. (1998) 'Witnessing identification: latent fingerprinting evidence and expert knowledge', *Social Studies of Science*, 28: 687–712.
Cole, S.A. (2001) *Suspect Identities: A History of Fingerprinting and Criminal Identification*. Cambridge MA: Harvard University Press.
Cole, S.A. (2004) 'Fingerprint identification and the criminal justice system: historical lessons for the DNA debate', in D. Lazer (ed.) *DNA and the Criminal Justice System*. Cambridge, MA: MIT Press.
Cope, N. (2003) 'Crime analysis: principles and practice', in T. Newburn (ed.) *Handbook of Policing*. Cullompton: Willan, 340–62.
Eco, U. (1983) 'Horns, hooves and insteps: some hypotheses on three types of abduction', in U. Eco and T.A. Sebeok (eds) *The Sign of Three: Dupin, Holmes, Peirce*. Bloomington, IN: Indiana University Press, 198–220.
Ericson, R.V. (1981) *Making Crime: A Study of Detective Work*. Toronto: Toronto Press.
European Data Protection Supervisor (2006a) *Opinion of the European Data Protection Supervisor on the Proposals for a Council Framework Decision on the Protection of Personal Data Processed in the Framework of Police and Judicial Cooperation in Criminal Matters, 19 December 2005*. Brussels: Official Journal of the European Union.
European Data Protection Supervisor (2006b) *Opinion of the European Data Protection Supervisor on the Exchange of Information under the Principle of Availability, 28 February 2006*. Brussels: EDPS.
Faigman, D.L., Kaye, D.H., Saks, M.J. and Sanders, J. (2002) *Science in the Law: Social and Behavioral Science Issues*. Saint Paul, MN: West Publishing Co.
Fereday, L. (2004) *Transforming the Use of Forensics through the DNA Expansion Programme. Beyond DNA in the UK – Integration and Harmonisation*. Newport, South Wales, London: Home Office.
Fisher, D. (1995) *Hard Evidence*. New York: Dell.

Forensic Science Service (1994) *The Scenes of Crime Handbook*. Chorley: FSS.
Forensic Science and Pathology Unit Home Office (2005) *DNA Expansion Programme 2000–2005: Reporting Achievement*. London: The Home Office.
Fosdick, R.B. (1915) [reprinted 1972] *European Police Systems*. New Jersey: Patterson Smith.
Fraser, J. G. (2000) 'Not science . . . not support: forensic solutions to investigative problems', *Science and Justice*, 40: 127–30.
Fraser, J. (2007) 'The application of forensic science to criminal investigation', in T. Newburn, T. Williamson and A. Wright (eds) *Handbook of Criminal Investigation*. Cullompton: Willan, 381–402.
Fraser, J. and Williams, R. (eds) (forthcoming) *The Handbook of Forensic Science*. Cullompton: Willan.
Gardner, R.M. (2004) *Practical Crime Scene Processing and Investigation*. New York: CRC Press.
Garland, D. (2001) *The Culture of Control: Crime and Social Order in Contemporary Society*. Oxford: Oxford University Press.
Gerlach, N. (2004) *The Genetic Imaginary: DNA in the Canadian Criminal Justice System*. Toronto: University of Toronto Press.
Gill, P. (1998) 'Making sense of police intelligence? The use of a cybernetic model in analyzing information and power in police intelligence processes', *Policing and Society*, 8: 289–314.
Gill, P. (2000) *Rounding Up the Usual Suspects*. Aldershot: Ashgate.
Ginzburg, C. (1980) 'Morelli, Freud and Sherlock Holmes: clues and scientific method', *History Workshop Journal*, 9: 5–36.
Ginzburg, C. (1983) 'Morelli, Freud and Sherlock Holmes: clues and scientific method', in U. Eco and T.A. Sebeok (eds) *The Sign of Three: Dupin, Holmes, Peirce*. Bloomington, IN: Indiana University Press.
Ginzburg, C. (1990) 'Clues: roots of an evidential paradigm', in *Myths, Emblems, Clues*. London: Hutchinson.
Green, R. (2007) 'Forensic investigation in the UK', in T. Newburn, T. Williamson and A. Wright (eds) *Handbook of Criminal Investigation*. Cullompton: Willan, 338–56.
Gross, H. (1924) *Criminal Investigations: A Practical Textbook for Magistrates, Police Officers and Lawyers*. London: Sweet & Maxwell.
Her Majesty's Inspectorate of Constabulary (HMIC) (2000) *Under the Microscope: Thematic Inspection Report on Scientific and Technical Support*. London: Home Office.
Her Majesty's Inspectorate of Constabulary (HMIC) (2002a) *Under the Microscope Refocused*. London: Home Office.
Her Majesty's Inspectorate of Constabulary (HMIC) (2002b) *Getting Down to Basics: Emerging Findings from BCU Inspections in 2001*. London: Home Office.
Home Office (1949) *Scientific Aids to Criminal Investigation*. London: HMSO.
Home Office (2003) *Police Science and Technology Strategy 2003–2008*. 1–28. London: Home Office.
Home Office (2000) 'The Government's Crime Reduction Strategy', http://www.homeoffice.gov.uk/crimprev.
Home Office (2005) *Maximising the Opportunities for Sharing DNA Information across Europe*, Conference Proceedings 24–26 October 2005, Chesford Grange Hotel, Warwickshire, UK. London: Home Office.
House of Commons Home Affairs Committee (1989) *The Forensic Science Service. HC Paper 26–1, Session 1988–9*. London: HMSO.
House of Commons Science and Technology Committee (2005) *Forensic Science on Trial*. London: HMSO.
House of Lords European Union Committee (2007) *18th Report of Session 2006–07. Prüm: An Effective Weapon against Terrorism and Crime?*, HL Paper 90. London: HMSO.

House of Lords Select Committee on Science and Technology (1993) *Report on Forensic Science*. London: HMSO.
Inman, K. and Rudin, N. (2001) *Principles and Practice of Criminalistics: The Profession of Forensic Science*. New York: CRC Press.
Innes, M. (2003) *Investigating Murder: Detective Work and the Police Response to Criminal Homicide*. Oxford: Oxford University Press.
Innes, M., Fielding, N. and Cope, N. (2005) 'The appliance of science? The theory and practice of crime intelligence analysis', *British Journal of Criminology*, 45: 39–57.
Jackson, A.R.W. and Jackson, J.M. (2004) *Forensic Science*. London: Prentice Hall.
James, S.H. and Nordby, J.J. (eds) (2003) *Forensic Science: An Introduction to Scientific and Investigative Techniques*. New York: CRC Press.
Jamieson, A. (2004) 'A rational approach to the principles and practice of crime scene investigation', *Science and Justice*, 44: 3–7.
John, T. and Maguire, M. (2003) 'Rolling out the National Intelligence Model: key challenges', in K. Bullock and N. Tilley (eds) *Essays in Problem-oriented Policing*. Cullompton: Willan, 38–68.
Johnson, P. and Williams, R. (2007) 'Internationalising new technologies of crime control: forensic DNA databasing and datasharing in the European Union', *Policing and Society*, 17: 103–18.
Kiely, T.F. (2006) *Forensic Evidence: Science and the Criminal Law*. London: Taylor and Francis.
Kirk, P.L. (1963) 'The ontogeny of criminalistics', *Journal of Criminal Law, Criminology and Police Science*, 54(2): 235–8.
Langford, A., Dean, J., Reed, R., Holmes, D., Weyers, J. and Jones, A. (2005) *Practical Skills in Forensic Science*. Harlow: Prentice Hall.
Lazer, D. (ed.) (2004) *DNA and the Criminal Justice System: The Technology of Justice*. Cambridge, MA: MIT Press.
Lee, H.C., Palmbach, T. and Miller, M.T. (2001) *Henry Lee's Crime Scene Handbook*. San Diego: Academic Press.
Loader, I. (2004) 'Policing, securitisation and democratisation in Europe', in T. Newburn and R. Sparks (eds) *Criminal Justice and Political Cultures: National and International Dimensions of Crime Control*. Cullompton: Willan.
Lyman, M.D. (1999) *Criminal Investigation: The Art and the Science*. New Jersey: Prentice Hall.
Maguire, M. (2000) 'Policing by risks and targets: some implications of intelligence led-crime control', *Policing and Society*, 9: 315–36.
Manning, P.K. (1977) *Police Work: The Social Organisation of Policing*. Cambridge, MA: MIT Press.
Marx, G. (1988) *Undercover Police Surveillance in America*. Berkeley: University of California Press.
McCartney, C. (2004) 'Forensic DNA sampling and the national DNA database: a sceptical socio-legal analysis', *Critical Criminology*, 12: 157–78.
McCartney, C. (2006a) *Forensic Identification and Criminal Justice: Forensic Science, Justice and Risk*. Cullompton: Willan.
McCartney, C. (2006b) 'The DNA expansion programme and criminal investigations', *British Journal of Criminology*, 46: 175–92.
McCartney, C. (2008) 'LCN DNA: proof beyond reasonable doubt?', *Nature Genetics Review*, May. Online at: http://www.ircm.qc.ca/bioethique/obsgenetique/.
McCulloch, H. (1996) *Police Use of Forensic Science*. London: Home Office Police Research Group.
McCulloch, H. and Tilley, N. (2000) *Effectiveness and Efficiency in Obtaining Fingerprint Identifications*. London: Home Office.
Morgan, J.B. (1990) *The Police Function and the Investigation of Crime*. Aldershot: Avebury.

Morgan, J., Ponikiewski, N. and Dunstan, E. (2004). *The Processing of Fingerprint Evidence after the Introduction of the National Automated Fingerprint System*. Home Office online report 23/04. London: Home Office.

Morris, B. (2007). 'History of criminal investigation', in T. Newburn, T. Williamson and A. Wright (eds) *Handbook of Criminal Investigation*. Cullompton: Willan, 15–40.

Murphy, E. (2007) 'The new forensics: criminal justice, false certainty and the second generation of scientific evidence', *California Law Review*, 95: 720–97.

National Criminal Intelligence Service (NCIS) (2000) *The National Intelligence Model*. London: National Criminal Intelligence Service.

National DNA Database (2007) *Annual Report 2005–2006*. London: The Forensic Science Service.

Newburn, T., Williamson, T. and Wright, A. (2007) *Handbook of Criminal Investigation*. Cullompton: Willan.

Nickell, J. and Fischer, J. (1999) *Crime Science: Methods of Forensic Detection*. Lexington KY: University of Kentucky Press.

Nordby, J.J. (2000) *Dead Reckoning: The Art of Forensic Detection*. Boca Raton, FL: CRC.

Nuffield Council on Bioethics (2007) *The Forensic Uses of Bioinformation*. London: The Nuffield Foundation.

Osterburg, J.W. and Ward, R.H. (2000) *Criminal Investigation: A Method for Reconstructing the Past* (3rd edn). Cincinnati: Anderson Publishing Co.

Pepper, I. (2005) *Crime Scene Investigation*. Maidenhead: Open University Press.

Prime, R. and Hennelly, L. (2003) *Effects of the Processing of DNA Evidence*. London: Home Office.

Pyrek, K. (2007) *Forensic Science Under Siege: The Challenges of Forensic Laboratories and the Medico-Legal System*. Amsterdam: Elsevier.

Ramsey, M. (1987) *The Effectiveness of the Forensic Science Service*. Home Office Research Study 92. London: HMSO.

Redmayne, M. (2001) *Expert Evidence and Criminal Justice*. Oxford: Oxford University Press.

Ribaux, O. and Margot, P. (1999) 'Inference structures for crime analysis and intelligence using forensic science data: the example of burglary', *Forensic Science International*, 100: 193–210.

Ribaux, O. and Margot, P. (2003) 'Case-based reasoning in criminal intelligence using forensic case data', *Science and Justice*, 43: 135–43.

Ribaux, O., Girod, A., Walsh, S.J., Margot, P., Mizrahi, S. and Clivaz, V. (2003) 'Forensic intelligence and crime analysis', *Probability Law Risk*, 2: 47–60.

Ribaux, O., Walsh, S.J. and Margot, P. (2006) 'The contribution of forensic science to crime analysis and investigation: forensic intelligence', *Forensic Science International*, 156: 171–81.

Rix, B. (2004) *The Contribution of Shoemark Data to Police Intelligence, Crime Detection and Prosecution*. London: Home Office.

Roberts, P. and Willmore, C. (1993) *The Role of Forensic Science Evidence in Criminal Proceedings*. Royal Commission on Criminal Justice Study 11. London: HMSO.

Roberts, P. and Zuckerman, A.A.S. (2004) *Criminal Evidence*. Oxford: Oxford University Press.

Roman, J.K., Reid, S., Reid, J., Chalfin, A., Adams, W. and Knight, C. (2008) *The DNA Field Experiment: Cost Effectiveness Analysis of the Use of DNA in the Investigation of High-Volume Crimes*. Washington: Urban Institute.

Rose, N. (1999) *Powers of Freedom*. Cambridge: Cambridge University Press.

Rose, N. (2000a) 'Government and control', *British Journal of Criminology*, 40: 321–39.

Rose, N. (2000b) 'The biology of culpability: pathological identity and crime control in a biological culture', *Theoretical Criminology*, 4: 5–34.

Saks, M.J. and Koehler, J.J. (2005) 'The coming paradigm shift in forensic identification science', *Science*, 309: 892–5.

Saulsbury, W., Hibberd, M. and Irving, B.L. (1994) *Using Physical Evidence: An Examination of Police Decision Making*. London: The Police Foundation.
Smith, N. and Flanagan, C. (2000) *The Effective Detective: Identifying the Skills of an Effective SIO.* Research Series. London: The Home Office.
Steer, D. (1980) *Uncovering Crime: The Police Role.* Royal Commission on Criminal Procedure Research Study No 7. London: HMSO.
Steventon, B. (1993) *The Ability to Challenge DNA Evidence.* Royal Commission on Criminal Justice Research Study 9. London: HMSO.
Thompson, W.C. (1993) 'Evaluating the admissibility of new genetic tests: lessons from the ''DNA War'' ', *Criminal Law and Criminology*, 22: 84–104.
Thompson, W.C. (1995) 'Subjective interpretation, laboratory error and the value of DNA evidence: three case studies', *Genetica*, 96: 153–68.
Thompson, W.C. (1997) 'A sociological perspective on the science of forensic DNA testing', *University of California, Davis Law Review*, 30: 1112–36.
Thompson, W.C. (2005) Analyzing the relevance and admissibility of bullet-lead evidence: did the NRC report miss the target?, *Jurimetrics*, 46: 65–89.
Tilley, N. (2003) 'Community policing, problem-oriented policing and intelligence-led policing', in T. Newburn (ed.) *Handbook of Policing*. Cullompton: Willan.
Tilley, N. and Ford, A. (1996) *Forensic Science and Police Investigation.* London: Home Office.
Touche Ross (1987) *Review of Scientific Support for the Police.* London: Home Office.
Townley, L. and Ede, R. (2004) *Forensic Practice in Criminal Cases*. London: The Law Society.
Truzzi, M. (1983) 'Sherlok Holmes: applied social psychologist', in U. Eco and T.A. Sebeok (eds) *The Sign of Three: Dupin, Holmes, Peirce.* Bloomington IL: Indiana University Press, 81–118.
Walker, N. 2002. 'The problem of trust in an enlarged area of freedom, security and justice: a conceptual analysis', in M. Anderson and J. Apap (eds) *Police and Justice Co-operation and the New European Borders.* The Hague: Kluwer Law International.
Webb, B., Smith, C., Brock, A. and Townsley, M. (2005) 'DNA fast-tracking', in M.J. Smith and N. Tilley (eds) *Crime Science: New Approaches to Preventing and Detecting Crime*. Cullompton: Willan, 167–90.
Werrett, D.J. and Sparkes, R. (1998) '300 matches per week: the effectiveness and future development of DNA intelligence databases', *Ninth International Symposium on Human Identification.* Wisconsin: Promega Corp.
White, P. (1998) *Crime Scene to Court: The Essentials of Forensic Science.* London: Royal Society of Chemistry.
White, P.C. (1999) *Crime Scene to Court: The Essentials of Forensic Science*. London: Royal Society of Chemistry.
Williams, R. (2002) *Crime Scene Examination: Aspects of an Improvised Practice: Report to Durham Constabulary.* Durham: Department of Sociology.
Williams, R. (2004) *The Management of Crime Scene Examination in Relation to the Investigation of Burglary and Vehicle Crime*. Home Office RDS online report 24/04.
Williams, R. and Johnson, P. (2006) 'Inclusiveness, effectiveness and intrusiveness: issues in the developing uses of DNA profiling in support of criminal investigations', *The Journal of Law, Medicine & Ethics*, 34: 234–47.
Williams, R. and Johnson, P. (2007) 'Trace biometrics and criminal investigations', in T. Newburn, T. Williamson and A. Wright (eds) *Handbook of Criminal Investigation*. Cullompton: Willan, 357–80.
Williams, R. and Johnson, P. (2008) *Genetic Policing: The Use of DNA in Criminal Investigations*. Cullompton: Willan.
Wilson, T. (forthcoming) 'Forensic science and the internationalisation of policing', in J. Fraser and R. Williams (eds) *The Handbook of Forensic Science*. Cullompton: Willan.