An Overview of Crime Scene Practice and its Practitioners in the United Kingdom

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AN OVERVIEW OF CRIME SCENE PRACTICE AND ITS PRACTITIONERS IN THE UNITED KINGDOM

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FOR MY PARENTS
Matiur and Mahbuba

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ABSTRACT

Contemporary studies into crime scene practice and its practitioners have outlined a divide between the portrayals of the discipline in popular culture, and reality. Conceptualizations of crime scenes beyond physical spaces is limited, despite its potential to inform operational strategies, management and policy if viewed conceptually. This thesis formulated and proposed a novel conceptualization of scenes as complex, dynamic chaotic systems existing within microecosystems, highlighting the unseen dynamics of scene work. The effects of austerity policies in the United Kingdom and reduction in police numbers have for the past decade raised questions on the state of crime scene practice, particularly in relation to the effect of such measures on staff numbers, and scientific support spending. Through analysis of practitioner numbers, law enforcement spending on scene work, and the roles, responsibilities and expectations of law enforcement pertaining to scene workers, an overall understanding of scene practice, potential size of the crime scene workforce and the investment of the state on the same, has been presented in quantitative and qualitative formats using the seldom-utilized, but methodologically robust UK freedom of information legislation(s) (FOIL). The historical developments and precursors to modern crime scene practice was examined to determine the social, cultural, political and legal factors in the enactment of fact-based systems of guilt and innocence, and their continued influence on current criminal justice apparatus. Diminishing financial and infrastructural investment from the state invoked questions surrounding the quality assurance (QA) and quality control (QC) systems currently in place; the increased reliance on mechanization, and attitude of automation of austerity regimes; viability of scene practice being taken over by machines; and, future of the discipline in times of fiscal austerity. These matters have been comprehensively investigated followed by recommendations to improve existing systems and implement policies which hold potential to elevate scene practice to its maximum potential.

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CHAPTER ONE

Human knowledge is a cross between agreement and belief. Personal experience and discovery play a minor part in this knowledge system. Living in any society, in any time period, involves learning to accept what society believes to be true, in that point in history. Being a member of the society, to feel a sense of belonging, therefore involves consensus amongst the members. Recent debates concerning groups such as flat-earthers (those who question that the world is round), and climate change deniers demonstrates the growing divide between warring groups who each believe their thoughts to be facts.

Republican candidate Donald J. Trump, who ultimately became the 45th President of the United States of America ran on a platform of anti-science, and climate change denial (Chowdhury, 2017c). Despite 70 percent of Americans agreeing that climate change exists, but interestingly, only 13 percent were aware that almost all climate scientists (more than 90%) are of the view that human-caused global warming is occurring (Leiserowitz et al. 2017). The question thus appears to be, if the majority of Americans are unaware of scientific consensus on the matter, where are they getting their information?

The basis of knowledge is agreement. As it is impractical to rely on personal experience and discovery alone for knowledge accumulation, often members of society believe what others tell them to be facts. For example, four in ten Americans (40%) say they have personally experienced the effects of global warming, while the rest say they have not. Yet, there is agreement amongst seven in ten Americans, that climate change exists. To explain this apparent discrepancy would be to examine how reality itself is constructed.

An assumption has to be made in order for this discussion to be effective — there are multiple ways for a member of society to acquire knowledge. Personal experience, observation and discovery have historically been the basis for declaration of the truth or reliability of a matter. For example, it would not take an individual a science degree or extensive laboratory testing to understand and accept that ice is cold, or that sharp objects penetrating the skin causes a painful sensation. Apparent scientific phenomenon such as the directions in which, the sun rises and sets, is a matter of agreement amongst members of the public, as these are easily testable through personal observation, if such is needed. In most cases, however, when a personal belief or understanding conflicts with society's consensus on the issue, it is likely that the individual will surrender personal belief and observation in favour of the consensus. This is mostly accurate, notwithstanding the cases where new scientific discoveries defy societal beliefs and have the potential to fundamentally shift the thinking on a specific subject.

An illustration of this is Charles Darwin and his theory of Evolution. Darwin was aware that once he announced his findings, he would become the centre of a debate between religion and

science. Genesis states that God created the world in six days; however, Darwin's theory postulated that the world and the organisms in it progressed over the course of millions of years. When Darwin first presented his theory, refuting the Bible's narrative, even his devoutly religious wife acknowledged that his arguments had validity, despite there being gaps in his theory. Darwin waited 23 years to present his work to the public, as societal consensus was deeply-rooted against him. However, Darwin's work has since, changed the manner in which society views the world and its history. Reality was moulded through production of new knowledge.

Reality can thus be described as a complicated concept. One difficulty surrounding what one knows, is that the mere act of knowing does not make a concept or event true. The other centres around the uncertainty of knowing something, about something, and whether or not that something is real. Humanity has wrestled with this question since the dawn of civilisation, and one of the strategies that have aided in this grappling has been scientific endeavour.

Agreement and Experiential Realities

Ultimately, we reside in a world of two realities (Maxfield & Babbie, 2009). Experiential reality can be explained as what can be known from direct experience. Agreement reality is understood to be things that are considered real because of public consensus. The first reality is the product of a person's own experience; the second is a consequence of what people have told that person to be real. The concept is palpable in the collective and individual understanding of science and its effects in constructing public consciousness.

Science provides an approach to both agreement reality and experiential reality. Scientists endure to establish and maintain criteria that must be met before they succumb to accepting an idea, theory or concept as reality — despite not personally experiencing it. In general, assertions must have both logical and empirical support. Suppositions must make sense, and it must be in line with observations of the world.

Galileo Galilei (1564–1642) arguably, more than any other Renaissance scientist established the Scientific Revolution. He used the works of Archimedes, Ptolemy, and Aristotle as the foundation for his own discoveries and repudiation of ancient theories about motion and the so-called heavens (Lawson, 2004). He reputedly was the first scientist to study the solar system and Milky Way with the telescope — a Dutch innovation that he had heard about, never seen, but managed to construct a superior version of. Many of his discoveries contradicted Aristotle. Galileo explained the contradiction by rationalising that had Aristotle possessed the advantages of seventeenth- century thought, the ancient scientist too would have discovered the errors of his theories of motion and the universe.

Both experiential and agreement reality are thus, subject to change. As a consequence of new experiences, observations and knowledge dissemination through the mechanism of social discourse, society's understanding and acceptance of seemingly improbable, and sometimes impossible concepts become part of everyday life. Science, therefore, affords a tangible approach to establishing reality through personal experiences, and translation and transmission of that reality to others by way of knowledge transfer.

A multitude of social, cultural, legal, professional and scientific developments in the criminal justice sphere and the forensic sciences since the 1970s have contributed to changes to the dynamics of the law-science nexus (Peterson & Leggett, 2006). The 1980s saw one of the most important scientific breakthroughs in the history of forensic science — DNA typing. There was also the enactment of the first computerized databases of forensic evidence, and professional quality assurance programs like accreditation of crime labs. The history (Lynch et al. 2010; Jamieson & Moenssens, 2009; Embar-Seddon & Pass, 2015; Lawless, 2016) and implications (Lynch, 2003; Mnookin, 2001) of these discoveries is well-documented.

However, it is safe to say that in terms of experiential reality very few members of the public will ever be in a position to achieve first-hand knowledge of the dynamics of forensic science, or for the purposes of this doctoral thesis, crime scene investigation. If agreement reality is thus the source of knowledge for the masses, it is worthwhile to examine the possible sources from which this information is derived.

Role of the Media, and Crime Programming in Reality Construction

Media representations and the advent of crime programming on television, radio and the internet has had a significant impact on public understanding of forensic science, and crime scene investigation. CSI: Crime Scene Investigation was the most-watched scripted TV show between 2000 and 2009 (Nielsen Media Research, 2000-01 et al). It brought crime scene investigation into mainstream entertainment and popularised forensic science discourse outside of academic quarters. Despite being critical of authenticity of the portrayal of forensic science and its practitioners by the programme, its popularity in law enforcement circles is notable (Stinson et al. 2007). Popularity of the genre was at an all-time high in the mid-2000s. CSI: Miami, a spin-off of the original CSI show, was the world's most popular programme in 2006 (BBC, 2006a).

The relevance of this discussion relates to the influential place that mass media holds in society. Television holds a powerful position in shaping public opinion. Images on the screen are meticulously constructed using codes of representation that are invisible to viewers but shape everything they see (Fiske, 2002). In this instance, code refers to its linguistics and semiology sense — a dictionary of meanings or effects. Every aspect of television is directed and

produced by codes that afford meaning to every image shown, from the actors, to their clothing, to their speaking styles, and the cinematography employed to portray them.

Powerful, often unexpected and disconcerting responses to movies and TV programmes are commonplace, though. Intense cognitive and affective connections with something they experience in the media, or intensely identify with a narrative or plot point can generate a memory, or an unexplained affective reaction to the images on the screen (Whitehouse-Hart, 2014). These experiences can become embedded in the viewers' minds as distinct memories. Television and film can thus enter the everyday lives of viewers, contributing to emotional responses and instigating imagination and thought. Film and television also afford valuable insights into the role of memory, identity and viewing.

One of television's functions is to inform the public of the realities that they cannot experience themselves. Thus, it can be argued to be a tool for construction of agreement reality. However, the functions of certain forms of programming place an increased emphasis on providing its audience with thrills, and entertainment, rather than be grounded in facts, at the expense of being uninteresting. This seeming absence of authenticity gave rise to the expression 'CSI effect' — a blanket term used by stakeholders to describe the possible consequences of viewers watching police procedurals and being ill-informed about law enforcement and the justice system to the extent that this misinformation reflexively begins to negatively affect the same.

Many have argued that programming which aims to be informative and claims realism may be taken beyond its entertainment value, and if such representations are in fact deviant from the norm, it creates a warped reality. This is however, a two-sided coin. The argument for such television shows is that their portrayal, regardless of the level of authenticity, exposes the public to concepts, ideas and technologies which they may not have been aware of at all, had the programmes not put them on display.

For a large section of the public, the media is the principal source of knowledge and perception information of criminal justice organisations and law enforcement (Skogan, 1990; Mawby, 1999; 2003; Reiner, 2000). Generally, police activity directly affects a relatively confined group at the foot of the social hierarchy, who are disproportionately the complainants, victims and/or offenders. It intersects largely with young males, rarely from middle-class or upper-class backgrounds. The latter have very little adversarial contact with the police other than for traffic offences (Reiner 1994; 2000; 2003). Those further up in the social ladder most often determine police prestige, power and resources (Reiner, 2010). Especially for this segment of the population, the media is the prime basis of perceptions of, and preferences about policing (Colbran, 2014).

In the 2002 Policing for London survey, 80 percent of respondents stated that the news media was their main source of information about the police, while 29 percent of respondents admitted that they received their information from 'media fiction' (Fitzgerald et al. 2002). The same survey conducted over a decade later found similar results, with word of mouth cited as a further source of information (Fitzgerald et al. 2017). In the British Crime Survey (2006–7), 59 percent of people said they got their information from television and radio news, with 10 percent citing media fiction. Reiner (2010) put forward that, former Commissioner of the Met Police, Sir Ian Blair may not have been fully joking in his 2005 BBC Dimbleby Lecture when he declared that 'lots of people in this country are actually undertaking a permanent NVQ on policing – it's called The Bill'.

The media representation of policing has been said to feed back into policing practice (Reiner 2010). In 2005, Sir Stephen Lander, the-then Chairman of the Serious and Organised Crime Agency (SOCA), stated that his organisation's main concerns would be 'set by the brainboxes in the Home Office, according to analysis of the prominence of different kinds of crime, measured by column inches in the press' (Bennetto, 2005).

Media depictions of the police can thus be argued to have significant power in terms of shaping perceptions and knowledge of policing as well as driving policy and practice. It is, however, not possible to gauge with any certainty how these are taken or understood. Citizens are not blank canvases. Their approach to TV can often be influenced by pre-existing knowledge, prejudgments and/or reservations (Jewkes, 2006). As most will usually have limited contact with law enforcement in any real capacity, it would be a reasonable assumption that citizens' ideas about the police, and their role in society would be informed by what can be witnessed on television and film, read or heard in the news.

The accuracy of crime programming in depicting the realities of real-life crime detection is therefore an important subject to examine. An increased attention to law enforcement and courtroom proceedings since the 1950s was the advent of a new genre of television programming — the police procedural drama. Owing its modern-day popularity to shows such as Law and Order (1990), and later to CSI: Crime Scene Investigation (2000), the genre has spawned a spate of research-significant programming.

Radio programme Dragnet (1949) in the US, was arguably the first mainstream police procedural drama. Jack Webb, the show's creator attempted to give audiences the most realistic and credible depiction of police life (Hayde, 2001). The crux of present-day debate over the purported 'CSI effect' and representations and realities of forensic science focuses on this very notion of realism. Webb became a regular fixture at the Los Angeles Police Department, riding along with real on-duty police officers, asking them questions, and observing them in their

natural setting. The object was to learn about police procedure, protocols, authentic law enforcement lingo, and the general attitudes within the force (Tregaskis, 1953). This authenticity was Dragnet's most appealing quality.

Television shows 'tend to embellish and exaggerate the science, ignore actual timelines for testing and raise expectations of the general public, law enforcement and judicial system to an extremely absurd and totally unrealistic level' (Wecht, 2003). These programmes routinely fail to accurately depict the many aspects of forensic science, giving a distorted picture that affects the system's integrity. Issues such as inadequate funding of crime labs and fallibility of science are ignored to prioritize and glamourize the role of physical evidence, such as DNA, which plays a minor role in criminal proceedings (Cooley, 2006).

The drab reality of forensic science in present-day law enforcement is the exact opposite of the 'fast-paced, sexy, high-tech world of crime-fighting' established by current police-procedural dramas (Roane, 2005). The psuedoreality of CSI can be described as 'forensic fantasy' having a largely negative impact on the criminal justice system.

Portrayals of forensic science are at best 'high-tech magic' where crimes are solved quickly and unerringly. The general consensus among prosecution and defence lawyers is thus, that television depictions of forensic science as not just science, but 'super science' (Schweitzer and Saks, 2007). Bonin (2003) found that there were a number of further inaccuracies in forensic science programming: (1) unlike their television counterparts, real crime scene investigators do not all drive SUVs; (2) they do not dress in designer clothing or luxury watches, e.g. Armani suits at crime scenes (as lead character Horatio Caine [CSI Miami] routinely did), or cargo shorts and concert t-shirts (worn by Tim Speedle [also CSI Miami]); (3) it is not standard for crime scene investigators to carry guns, and to join armed raids; (4) lost within the glitz and glamour of television crime dramas is the most important work of all investigators… paperwork; (5) real crime labs do not have 'mood lighting'; on the contrary, the lighting is incredibly bright and unattractive in reality.

The equipment used on television is however, firmly rooted in reality (Lovgren, 2004). The gadgetry that is seen on TV is very close to what is used in real life, although, the major difference is the application of that technology. For example, a technique where casting material is poured into a victim's wound to retrieve a mould of the murder weapon (shown repeatedly on CSI and similar shows) has been described as 'totally unrealistic' (Lovgren, 2004). The substantial number of cases, and time-sensitivity of forensic work within crime scene units often means that, unlike CSI, where the lead character slaves away until one case is solved, most forensic practitioners have to handle multiple, sometimes more than ten cases at a time.

Briggs (2009) found further inconsistencies with regard to crime programming. Unlike television: (1) crime scene investigators do not interrogate suspects; (2) DNA evidence takes longer than a few hours to process; (3) fingerprint evidence rarely has the same impact in court, as depicted on television; (4) most techniques and equipment, even if available in reality, are only used in the most serious cases, as crime labs are one of the most under-funded sectors in law enforcement.

The funding question and is relevance to this instant study, as well as the roles and responsibilities that embody crime scene examiners and forensic practitioners in the field. The object of this study is to best identify the composition of law enforcement crime scene staff, their duties, and the funding into crime scene investigation and its practitioners. Mass media portrayals as has been argued, is not the most reliable source of information on these matters. Published literature in the discipline is limited, and official sources are not up-to-speed on crime scene data. Media portrayals have been successful in several aspects regarding public awareness of forensic science, however.

Deutsch and Cavender (2008) attributed the success of CSI and its successors to a 'strategic web of forensic facticity'. They identified three key aspects the show had succeeded in: (1) bolstering its backstage police realism; (2) validating its science claims; and (3) making scientific crime detection both accessible and fun even as it disseminated and reinforced cultural meanings about criminals and the police. They argued that consistent with the procedural tradition, CSI drew upon real cases, and that its producers and consultants borrowed from news and media reports of actual crimes to add realism to the drama.

An example of this, is the episode of CSI: Miami, which was based on the real-life story of Natalee Holloway, an American teenager who disappeared on a trip to Aruba. The Holloway case had been characterized by public frustration over the inability of law enforcement to figure out what really happened, the CSI: Miami forensic team was able to solve the case with conclusive evidence by the end of the episode. Such programming can fill the psychological needs of its viewers and restore social order in times of decreased confidence in law enforcement and the criminal justice system (Tyler, 2006). Although, it can also lead to public second-guessing and questioning of the integrity and ability of law enforcement personnel to solve cases, which in itself can lower confidence in the criminal justice system.

This reality-shaping quality of television is of considerable importance. Media programming such as this, shapes reality with its representations of forensic science and police procedure in the media. News reports and academic commentators have long debated the existence and impact of the 'CSI effect', often unable to back their claims with hard facts or carefully conducted research. The inquiry is a useful segue for this doctoral thesis, on the argument that

gaps in knowledge can only be addressed and filled, when the gaps are properly identified for consideration, and examined using the proper methods, practices and methodologies.

The State of Forensic Knowledge

Criminological research has had a multifaceted journey spanning several centuries (Rafter, 1997; Rock, 1994; Lynch, 2000; Garland, 2002; Carrabine et al. 2014). It has been said to be a wider view of crime through a sociological lens (Cohen, 2018). It is a hybrid discipline (Zedner, 2011) which in modern times has been the interest of practitioners in philosophy, psychology, psychiatry, medicine, anthropology, law and most notably, social scientists (Popper, 1934; Halleck, 1971; Pearson, 1975; Foucault et al. 1978; Giddens, 1991; Beck, 1992a; Blackburn, 1993; Hale Jr, 1995; Bonta et al. 1998; Farrington & Loeber, 2000; Andrews & Bonta, 2014; Bonger, 2015).

Developmental histories of forensic science have not been plotted with such vigour. There are limited dedicated works in the area (Smyth, 1980; Bell, 2008; Lynch et al. 2010; Ramsland, 2014; Adam, 2015) with mostly mentions in others as part of an introductory chapter to a wider study of forensic science (Tilley & Ford, 1996; Rudin & Inman, 2000; Tilstone et al. 2006; Saferstein, 2013). The available commentary shares a number of shared characteristics in their structure. Crime scene work is presented as an incidental development to forensic science, beginning with late nineteenth century innovations, and strikingly little to no reference to social, political, cultural and most importantly legal factors which facilitated that advancement.

This ties in with literature examining the history of technological, economic and societal changes directly or indirectly influencing and affecting workplaces and work practices. In crime scene practice, the important drivers for its inception, development and maintenance, as well as the role of technological development can be an essential resource in understanding the impact of technology on societal change, and vice versa. This is known as ‘technological determinism’ in science and technology studies (STS) and can inform stakeholders on the past interactions of technology and society, and the possible future consequences of societal changes and technological advancements (Staudenmaier, 1985; Pinch & Bijker, 1987; Misa, 1988; Bimber, 1994). Sociological analysis surrounding the development of crime scene work, and its possible future in an increasingly technological world is unavailable (at the time of writing) and this thesis would contribute on the subject.

Sociological studies of forensic science (in other areas) have however, gained traction in the past three decades, although its full potential may still be relatively unrealised. Comprehensive examination of the discipline is limited, but progress has been made in recent times (Jasanoff, 1991; Lynch & Jasanoff, 1998; Cole, 2013; Lawless, 2016). Forensic technologies such as DNA fingerprinting has produced the bulk of the research (Lynch, 1990; Jobling & Gill, 2004;

Cole, 2007; Lynch et al. 2010). The legal, cultural and socio-political implications of DNA evidence in court occupied the academic sphere for decades (Thompson, 1996; Lynch, 2003; Saks & Koehler, 2005; Rothstein & Talbott, 2006). The lack of empirical research in the area has concerned stakeholders, though (Tulley, 2015).

Forensic science as a discipline had most of its research focus on its many flaws, mainly questionable methods and techniques (Risinger et al. 2002; Koppl, 2005; Peterson & Leggett, 2006). The scientific basis for the discipline was a point of contention (Saks & Faigman, 2008; Crispino et al. 2011). The OJ Simpson trial was the subject of much publicity and debate on forensic science (Jasanoff, 1998; Lynch, 1998; Cotterill, 2003). Following the case, commentators capitalised on the public fascination with the subject by focusing research around forensic science and its future potential (Cooley & Turvey, 2014).

Expert evidence has been a point of contention inside and out of court. Commentators devoted multiple studies on questionable experts and the lack of standards to enforce shoddy testimony (Jonakait, 1993; Epstein, 2014). There was large-scale debate surrounding pseudo and junk science, and about mechanisms to prevent their use in courts (Huber, 1991; Gold et al. 1993; Fisher, 2008; Pyrek, 2010; Saferstein, 2013; Morrison, 2014). DNA exonerations, and miscarriages stemming from these disputed technologies and techniques also accounted for a wide class of studies (Thompson, 2008; Garrett & Neufeld, 2009; Huff & Killias, 2010; Cole, 2011). Forensic science has been said to face equal challenges from both the scientific community, as well as the legal fraternity (Pyrek, 2010).

Research was also published in bulk on the condition of primarily state-funded crime laboratories (DiFonzo, 2005; Giannelli, 2007; Reardon, 2014; Garrett, 2016). Revelations such as lack of funding, sub-standard service, and non-enforcement of quality assurance and quality control facilitated continued enquiries into the subject (Giannelli, 1996; Driscoll, 2014). These led to research on avenues for reform of the discipline, as well as the community as a whole (Cooley, 2004).

Statistical models such as likelihood ratios and probabilistic inference in forensic science have been covered in some detail (Aitken & Leese, 1995; Aitken & Taroni, 2004; Taroni et al. 2006). Bayesian networks have been the focus of many of these studies (Evett et al. 2001; Garbolino & Taroni, 2002). Commentary on potential bias of expert witnesses (Dror et al 2006; Murrie et al. 2013), investigators (Dror & Cole, 2010; Dror & Hampikian, 2011; Kassin et al. 2013) and even jurors (Kassin & Wrightsman, 1983; Baskin & Sommers, 2010; Shelton, 2010; Smith et al. 2011) were the subject of a large volume of published work (Champod, 2014). These were supplemented with studies on the validity and reliability of scientific methods, and techniques.

Crime scene work has mostly been defined in textbooks or guides (Miller, 2002; Fisher & Fisher, 2003; Horswell, 2004; Ballou, 2010; Pepper, 2010; Gardner, 2011). Recent debates have concerned whether aspects of forensic science, like crime scene work are scientific (Fraser, 2000; Millen, 2000; Harrison, 2006; Gardner, 2011). There were arguments for the notion, although these fell in the minority (Rudin & Inman, 2000; Horswell, 2004; Pepper, 2010; Houck et al. 2017). Crime scene-related research is limited in scope and numbers compared to forensic science as a whole. The discipline's principal concern has appeared to be issues governing admissibility of evidence (Black, 1988; Saks, 2002; Mnookin, 2009; Robertson et al. 2016), often overlooking the importance of scene work, or its practitioners.

Commentators have contributed heavily to the 'CSI Effect' and the overall impact of the media on forensic science and its outcomes in court (Cooley, 2006; Heinrick, 2006; Podlas, 2006; Schweitzer & Saks, 2007; Cole & Dioso-Villa, 2008; Cole, 2015). The cultural significance of crime programming and forensic science depictions in the media brought forward new concerns about effects on jurors, judges, lawyers and even the general public (Podlas, 2005; Tyler, 2005; Cavender & Deutsch, 2007; Ley et al. 2012; Cole & Dioso-Villa, 2011). Therefore, the responsibility on academic and practitioner literature to bridge the knowledge gap between reality and practice is great.

Professionalism in crime scene work has been a concern for academics and practitioners (Kelty, 2011; Kelty et al. 2011, 2017; Houck, 2015). There have been concerns about the limited understanding of scene work and its role and scope in criminal investigations (Ludwig et al. 2012; Julian et al. 2012; Wilson-Kovacs, 2014; Wyatt, 2014).

The value of forensic science has also been questioned (Julian et al. 2011; Ribaux et al. 2017). There are marked challenges for the forensic science community, such as caseloads, lack of resources, insufficient quality control and lack of scientific basis in areas of forensic expertise (Saks & Koehler, 2008; Garrett & Neufeld, 2009; Ulery et al. 2011; van Asten, 2014). However, few studies in these areas exist with a crime scene investigation spotlight.

Quality control and assurance in crime scene work is a major focus of this thesis. The Council for the Registration of Forensic Practitioners (CRFP) was shut down in 2009 after a decade in operation in the UK. Its establishment was credited to a series of high-profile miscarriages of justice, including the Guildford Four and Birmingham Six cases (Edmond, 2002). It was responsible for accrediting forensic science professionals, and ensuring competence and quality standards (Mennell, 2006). No such government organisation replaced it (Janaway, 2015).

The Home Office and National Policing Improvement Agency suspended the £500,000 annual operational cost of the organisation (Evison et al. 2013). The CRFP relied on a system of peer review which has been argued to have been a better procedure than mere judgements made by

users of forensic science services who care more about results than how they had been achieved (Wilson and Gallop, 2013). Its closure meant that a register of more than 3,000 independent experts in fields such as fingerprinting, ballistics, computing and DNA were lost (The Guardian, 2009).

The CRFP was established to afford courts a point of reference on the competence of forensic practitioners, with the overriding objective to promote public confidence in forensic practice in the UK (House of Commons, 2005). The publication of a register of competent forensic practitioners ensured that registered practitioners remained up-to-date and maintained competence; and disciplining registered practitioners who did not meet the required standards (Home Affairs Committee, 1999). The office of the FSR was not established to engage in any of these activities (CRFP, 2008). The FSR's confidence to ensure competence was announced to be in forensic science managers (FSR, 2013).

Concern has been expressed by policymakers about the future of the forensics market in the UK (House of Commons, 2013). There is a significant lack of data on the overall size of the forensics market and the proportion of it delivered in-house by police force laboratories, a lack of consistent accounting practices across police forces making it challenging to get a complete picture of forensics expenditure, and absence of an official strategy to ensure the forensic market is in good health, both in the short and long-term (NAO, 2014).

There have been examinations of the forensic science market in the UK (Lawless, 2011), as well as the commercialisation of the forensic scientific provision (Lawless & Williams, 2010). There is however, limited data on the market with relation to crime scene work. The extraction and study of this data would be invaluable in understanding the potential resources allocated to crime scene work, in relation to scientific support, and more broadly as a comparison to policing expenses.

The Forensic Science Service (FSS), the government-owned company responsible for providing forensic science services to UK police forces was wound up by the Home Office in 2012 (Morris, 2012; Rennison, 2014). It was an organisation which had operated since 1991 but closed its doors after data emerged that it was losing £2m a month (BBC, 2013). The closure cost the Conservative government £95m and made 1,600 people redundant. The potential impact of this closure has been speculated, but not examined in any detail. The most impactful areas would concern internal staffing numbers at police forces, any changes in spending on laboratory and/or crime scene expenses, organisational changes, and the redistribution of work.

The Forensic Science Regulator (FSR) does not have statutory powers to enforce quality standards or management regulations (Wilson et al. 2014), and failure to address these failings was speculated by the FSR herself to potentially cause miscarriages of justice in the future

(Tully, 2018). Improper manipulation of quality control data in forensic toxicology (p. 4), lack of investment in quality control (p. 10) risks concerning the forensic science market (p. 8), and the overall lack of understanding of quality across the criminal justice system (p. 12) were highlighted in the 41-page FSR report covering 2016-2017. The bulk of the report focused on issues at the laboratory (p. 6) and called for improvement of digital forensics standards (p. 13, 21, 26). There was a mention of 'crime scene standard' (p. 13) but there was no elaboration on the meaning or scope of such a standard.

Crime scene standards are one of the most under-examined areas of the field. Forensic practitioners have traditionally resisted the idea of standardization of their work practices for the reason that no crime scene is the same as one before, and every case is different, along with arguments that samples collected at crime scenes are too small and homogenous for such standardisation of methods to be effective (Lentini, 2009). The closure of the CRFP made accreditation for crime scene practitioners with a state body unachievable. There is limited literature on the scope of national certification schemes for crime scene personnel (Gardner, 2011). However, none of the studies comprehensively evaluate these in real-world terms, instead opting for a more conceptual, generalised approach to quality (Horswell, 2004; Shaler, 2011). As an explanation, it has been said that forensic science is a success-based practice where quality is secondary, as long as it gets the job done (Smith, 2014).

The management paradigms and knowledge-management systems of the organisations that are the principal users and customers of forensic science have limited literature (Gottschalk, 2006; Seba & Rowley, 2010). Empirical studies are few and far on the expectations of these users of who crime scene practitioners should be (Ludwig et al. 2012) and what their roles are (Williams, 2004). The boundaries of their work, and the differences between the many designations of these practitioners used interchangeably without empirical justification, is however largely unexplored.

The recognition of these roles and boundaries is important for a number of reasons. Knowledge about these practitioners, their roles, the limits and scope of their work can equip their employers to formulate better policies tailored to their needs, their end users and customers to have grounded and realistic expectations of their work, and open avenues for further research in the academic and research community.

The twenty-first century has seen police facing a global crisis. Structural reorganisation, budgets cut and pushbacks against traditional approaches to maintaining the order have introduced new challenges (Fyfe et al. 2013). Additionally, evidence-based, intelligence-led, professional approaches for the modernisation of policing have led to policy changes (Den Boer, 2014). Previously well-established functions in society are consistently shifting due to

private sector involvement, and emergence of new security and safety providers, collaborative arrangements, networks and partnerships (Hoogenboom, 2010). New forms of networks, nodal governance and pluralistic systems (Frevel & Rogers, 2016; Shearing & Johnston, 2010; White, 2011) have come to be seen as more mobile, cost-effective responsive solutions in maintaining society's security than the old bureaucratic and centralized systems of governance.

Driven by similar goals, the changes towards 'digital-era' governance in the UK have had far-reaching impact across all sectors (Margetts & Dunleavy, 2013; Moss & Coleman, 2014). The Conservative-Liberal Democratic Coalition Government, which took power in 2010 underscored the capacity of technology to reinvigorate democratic politics. The Conservative Party utilized contemporary digital lingo to emphasize the use of mechanisms such as the internet to consult the masses for aspects of policy and decision-making. This followed a twentieth century vision for a technological society where machines and humanity would operate in perfect synergy (Featherstone & Burrows, 1996).

There was speculation in the early twentieth century of technology creating largescale unemployment (Keynes, 1933). By the end of the century, this proved to be accurate with respect to bookkeepers, cashiers and telephone operators (Bresnahan, 1999). Smart meters replaced electricity meter readers with other more futuristic road maps such as reducing the number of bank tellers with ATM's sporting screens with human avatars being close to reality (Time, 2012; Deloitte, 2015).

After the new millennium, the change towards a more technological workforce continued with other middle-skill occupations suffering the most (David & Dorn, 2013; Acemoglu & Autor, 2011). Studies found a decline in such occupations in favour of high-skill white collar jobs and low-skill operations (Gray, 2013; Katz & Margo, 2014). Automation has been seen to already play a key role in forensic practice, with increasing reliance on technology a telling trend (Spratt, 1999; Mennell & Shaw, 2006). The potential impact of these preferences and shift in societal valuation of the workforce on crime scene personnel has remained generally unexplored.

The lack of understanding on the subject owes itself to the underexamined concept of skill, as it applies to crime scenes and its practitioners. There is some literature on the potential meaning of professionalism in crime scene work (Kelty et al. 2011), which has often been misinterpreted to be 'organisational expectations' (Wilson-Kovacs, 2014: 4). Ludwig et al. (2012) is most frequently cited as a source for understanding of crime scene personnel roles from the perspective of law enforcement organisation staff. However, the study utilised survey data and not official documents to reach conclusions. A corroborative follow-up to it, with human

resource literature would therefore benefit the overall knowledge about the roles and responsibilities of crime scene personnel.

The publication of the police workforce in England and Wales is an annual occurrence. Listed under the National Statistics header, the reports outline the statistics on police workforce numbers in the 43 police forces in the two jurisdictions, as well as the British Transport Police (Home Office, 2018a). The statistics include the records of police officers, police staff, police community support officers and designated officers. However, there has been no mention in any of the published government literature on the numbers employed in police organisations who provide scientific support, which of the above categories such staff will fall under if at all, whether crime scene practitioners are civilian contractors, or the means by which classifications of the published staff are formulated.

Human resource data is therefore key in uncovering the size of the crime scene practitioner workforce. The labels that are attached to their job descriptions, and the extension of these labels to the roles and responsibilities assigned to them can be extracted from the literature used to recruit such personnel. The numbers at least, in theory, are a standard bookkeeping entry and should exist as part of personnel records and/or financial documentation.

The return of austerity has been said to have provoked social conflict, political controversy and academic disputes (Clarke & Newman, 2012). There has been increased attention on the role of the police after the post-austerity era under the 2010 Coalition government (Reiner, 2015). The police had experienced sustained growth until austerity measures reduced numbers and stunted growth in England and Wales by an estimated 20 percent leading up to 2015 (Millie, 2013). The number and roles of frontline operational support workforce, of which scientific support and by extension crime scene staff are a part, faced planned reductions of 27% from 2010 to 2015 (HMIC, 2014). The report described operational support as “functions or departments in a police force which support police officers and staff in frontline roles, such as intelligence departments which provide assistance for investigations and scientific support which assist in relation to forensic evidence” (p. 13). However, as it was unclear whether forces classified their scene workers as police staff or as civilian contractors, no determination as to whether these austerity policies had any impact on scene personnel could be made from available literature.

Police finance data is also not recorded with forensic science expenses or crime scene spending labelled or stratified, instead overall grant figures reported by allocation year (Home Office, 2018b). Individual forces spending data as part of transparency policies and improving public image, but these also do not lay out finances to pinpoint spending in specific areas like forensic science and/or scientific support. Empirical work is therefore the only means employable to gain insights into these areas.

Empirical research in crime scene work has however, been found to be observably limited (Wilson-Kovacs, 2013). Ludwig et al. (2012) described their look into the roles and perceptions concerning crime scene examiners as a large and extensive study. The work used survey data from forensic science provision in the two largest police forces in Scotland and by the four main Scottish Police Services Authority Forensic Services (SPSA FS) units. Williams (2004) as part of a Home Office study worked with seven forces for one of the most informative examinations of crime scene work in relation to burglary and vehicle crime. It has been claimed that until 2011 there was no empirical literature on the types of skills and attributes that are important to crime scene work (Kelty & Gordon, 2012). This thesis will examine these issues and through empirical research, attempt to construct the state of crime scene work in the UK, by combining financial data, personnel information and human resource literature from all 43 police forces in England & Wales as well as Scotland and Northern Ireland.

The activities at homicide crime scenes have been analysed to assist in understanding different styles of homicide and the kind of person responsible for each of the styles (Salfati & Canter, 1999; Santtila et al. 2001; Salfati & Dupont, 2006). These action-based studies have been supplemented by attempts to conceptualise crime scene investigation itself as an action. The causal and temporal relationships between the various objects involved in a criminal incident and their underlying foundations have been proposed (Gardner, 2016). There was also recognition for a need to view crime scene work conceptually (Fisher & Fisher, 2003; Gardner, 2011). Crime scene management was conceptualised as a fundamental component of forensic science (Julian et al. 2012; Crispino, 2008). These culminated in attempts to frame crime scene work conceptually with regard to the fragility of evidence, and the interaction of scene personnel with evidence in an 'evidence matrix' (Miranda, 2015).

Most of the work in the area focused on the practitioners being aware of a changeable crime scene, where the blanket terms such as time, and degradation were used to describe the fragile nature of evidence. However, the subject would benefit greatly from conceptualisation of crime scenes first, and then introduce scene practitioners and other law enforcement actors as another variable with potential to affect the state of the scenes with their actions and inactions. Formulating a novel approach to crime scene work, as systems analysis could assist with not only conceptualisations of scenes beyond physical spaces, but aid the placing of personnel in these spaces to determine their exact roles and influences on these spaces and beyond.

In the past, activities at the crime scene were seen to be 'police work' and the processing and managing of the scene as a technical discipline (Crispino, 2008; Millen, 2000). The meaning of expertise in forensic science, and by extension crime scene work has been the subject of limited examination with most classifications aiming to stratify practitioner roles within police

organisations (Williams, 2004; Williams, 2008; Ludwig et al. 2012; Williams & Weetman, 2013).

It has been speculated that the changing nature of the world in terms of advancing technology and continuously evolving threats stemming from them, will push law enforcement organisations into reinventing themselves to keep pace (Inayatullah, 2001; 2013). The relentless advancement of technology has been said to mean that those responsible for managing crime will feel an obligation to ascertain and extrapolate emerging and future applications of science and technology to detect and reduce crime as well as predict how technology will be used by criminals in the future (Mennell, 2006). The use of drones for crime scene photography and reconnaissance is an example of technology adoption for crime investigation (Robinson, 2016; Villasenor, 2014; Smith, 2015), with several futuristic potential uses, such as thermal imaging already proposed (Lega et al. 2014). It has raised public concerns about privacy and potential mass surveillance of citizens by an overbearing state (Reid, 2013; Sakiyama et al. 2017; Friedenzohn, 2018).

These developments led to the conceptualisation of potential technologies for use in future crime scenes. One such technical development was a robotic crime scene imaging system that was built by the author of this thesis. The concept, a NASA-inspired rover (Chowdhury, 2016; Chowdhury, 2017a) which could record crime scenes in 360° to be viewed later in virtual or augmented reality received widespread attention, most notably from the American Bar Association (Dixon Jr, 2016), the Federal Bureau of Investigation (FBI) and the National Institute of Standards and Technology (Chowdhury, 2017b). The mechanism stands as an alternative to drone usage to record internal crime scenes not suffering from the same scepticism of privacy invasion or surveillance and has been stated to be a future tool to record vast amounts of crime scene data unimaginable in the past (Van & Vanderveen, 2017; The Atlantic, 2017). The deductive reasoning model, as outlined by Gray (2013) was utilised in order to progress through the development process of the robotic imaging system, and stands as a separate and notable contribution of this doctoral thesis.

The identification of a problem scenario and the subsequent search to formulate a solution by the author of this thesis were purely sociological endeavours, which resulted in the production of not just new knowledge, but also technology. The developments in the mode of knowledge production in contemporary societies has been said to be of great sociological significance (Gibbons, 1994). The production of new knowledge in the legal and forensic spheres has also been claimed to be a concern for sociology (Jasanoff, 2004). Studies of innovation, knowledge management and learning can lead to individuals and organisations becoming more efficient in these practices and inducing social change (Davenport & Prusak, 1998; Greenwood & Levin,

2006). Endeavours such as these have been dubbed as action research (McNiff, 2013) and this thesis will attempt to contribute to the growing list of research methods that can be used for crime scene-related studies by examining these theories and concepts.

With reference to research methods, the principal means for the collection of data in the thesis will be Freedom of Information (FOI) requests under the rights afforded in statutory provisions in England & Wales, Scotland, and Northern Ireland. FOI is a relatively neglected means of data production in the social sciences (Walby & Larsen, 2012). It has been described as a 'radically different perspective' to criminological research (King & Wincup, 2008: 390) and hailed to be a powerful tool in data gathering in the social sciences (Walby & Luscombe, 2017) despite the challenges pertaining to the unorthodox research designs required for the method, partial or non-responses, mis/unlabelled and unsorted data, late responses with varying timelines, and information in formats unsuitable for the research purpose (Lee, 2005; Ross & Whittaker, 2009; Hazell & Worthy, 2010; Savage and Hyde, 2014). There have been limited studies in the area with relation to the police (Cooke & Sturges, 2009; Johnson & Hampson, 2015) but none for crime scene-related research. This thesis will therefore, examine these issues and more, adding to the existing literature on FOI to make a contribution with specific focus on police organisations in England & Wales, Scotland, and Northern Ireland, the quality of their FOI mechanisms, commentary on their data management practices, and recommendations for improvement.

Research Questions, Aims and Objectives

The thesis would examine in detail the historical underpinnings of scene work and the developments that lead to its enactment despite systemic barriers resisting the same. From the historic, it would proceed to investigate the present understanding of scene science and whether it is complete, flawed or in need of revision. This would involve a comprehensive look at the occupational spaces in which scene science operates, i.e. crime scenes. Once an overview and critical understanding of scene work is elucidated upon, the next step would be to determine who operate within these spaces, leading to a comprehensive determination of their personal and group characteristics, as well as the standards they are held up to, by stakeholders, and themselves. The quality of service determination would serve as a platform for an examination of the longevity and resilience of scene practice as a vocation in a rapidly transforming, service-oriented model of policing.

The principle concerns of this thesis, with regard to the practice of crime scene work can be recapitulated in the following themes: (1) historic underpinnings; (2) occupational spaces; (3) identity and boundaries; (4) organisational dynamics; (5) community standards; and, (6)

longevity and resilience to technological replacement. They can be formulated as the following questions, under each of the above headers.

(1) *Historical Underpinnings*: (a) where does the practice of scene work originate; (b) what legal, political, cultural and social developments led to the inception and adoption of crime scene work; (c) how important were organisational factors in this development; which of these organisations and traditions have survived in modern times (so as to better protect them).
(2) *Occupational Spaces*: (a) can crime scenes be conceptualised beyond a physical space where evidence exists, and crime scene practitioners operate; (b) how can such a conceptual framework assist criminal justice actors achieve their goals more efficiently;
(3) *Identity and Boundaries*: (a) what are the roles and responsibilities of crime scene personnel; (b) how are these classified by the organisations that employ them; (c) are crime scene personnel civilian contractors or police officers; (d) what are the boundaries of their work;
(4) *Organisational dynamics*: (a) what is the impact on crime scene work, if any, as a result of austerity measures in England & Wales; what is the potential size of the crime scene workforce; what are the organisational expectations for crime scene personnel; how is data concerning crime scene work and its practitioners managed in organisations;
(5) *Community Standards*: (a) how are standards maintained in crime scene work? (b) what are the concepts of quality control and assurance in the field; (c) how can these be potentially improved;
(6) *Longevity and Resilience to Technological Replacement*: (a) can artificial intelligence and robotics replace crime scene personnel in the future? (b) what areas of their work are more vulnerable to replacement than others; (c) what are the qualities and characteristics that could insulate such personnel from potential replacement in the future.

On a broader sociological scale, this thesis aims to add to the literature on science and technology studies, history of criminal justice, sociology of forensic science, policing studies, sociology of work and occupations, alternative research methods for sociological and criminological investigations, and the sociology of knowledge.

Structure of the Thesis

Chapter Two — Tracing the Development of Crime Scene Investigation as a Discipline

This chapter examines the roots of physical evidence in legal proceedings. Significant social, cultural, political and most importantly legal developments culminated in the enactment of more fact-based determinations of guilt and innocence. These can be indicative of the core values that led to crime scene analysis and physical evidence collection and processing. Crime scene practice is considered by many to be a recent innovation in policing, however, a historical survey will demonstrate its roots in antiquity. Scene work is directly tied to not only scientific

innovations, but medicolegal traditions — which may have been the reason why physical evidence and forensic techniques pertaining to the human body were advancing at separate rates in different jurisdictions. The importance of the analysis pivots on the identification of the institutions and/or traditions which contributed both to the delay, and the progression towards recognition and adoption of crime scene investigation as a staple of criminal investigations. Identification of such has the potential to provide insight into the most important ideas, motivations and institutions that are central to the inception, and continued progression of crime scene investigation as a standalone discipline. Understanding these barriers can lead to the more informed policymaking and strategies to get the best out of crime scene work and its personnel.

Chapter Three — Conceptualising Crime Scenes as Systems Analysis

Conceptualisation of crime scenes beyond merely spaces where crimes have taken place has real-world benefits, in that, it can assist crime scene personnel better process scenes, crime scene managers plan evidence searches and recovery attempts more effectively and inform stakeholders the complexity of the work undertaken by scene practitioners.

The chapter addresses assertions by commentators that crime scene work is not scientific because it does not rigorously adhere to the scientific method. Most scientific methodologies follow linear principles of cause and effect, whereas crime scenes, in themselves, are nonlinear. In addition, they are complex and dynamic, making them almost impossible to analyse in linear terms. The interaction of multiple unknowable variables, non-adherence to the rules of superposition, and sharing characteristics with chaos theory are factors which set it apart from the traditional scientific method. But this does not automatically relegate it to being non-scientific.

Crime scene investigation/examination is a form of systems analysis which requires, as the chapter argues, understanding of scientific principles such as physics, chemistry, biology, as well as legal principles of warrants, search and seizure, admissibility and evidential relevance, along with anticipation of the unexpected in an unpredictable system of shifting, unknown variables, which only become apparent upon observation and measurement. The key questions for subsequent chapters concern that whether personnel with these desirable skills are being sought for these roles and responsibilities. Acknowledging the complexity of scene work, and the magnitude of the task at hand for crime scene practitioners can also produce better quality control, and quality assurance strategies in the field.

Crime scene work is a complicated endeavour. Mapping the methods and methodologies associated with the discipline has been a challenging area of research for commentators. Despite numerous grounded approaches to determining the nuances of everyday work for crime scene practitioners, stakeholders are no closer to understanding the unique challenges facing those in the field. This chapter attempts to contextualize the skills and the utilisation of cognitive acuities by these practitioners to achieve their individual and organisational goals.

The thesis argues that the real complexity of scene work is less the mechanical action of picking up an object, bagging and tagging it, or the manual collection of traces or fingerprints from a surface, and more the various stages of hypotheses building, testing, and proving/disproving, which leads to evidence discovery. The chapter can lend helpful context in understanding the contribution of crime scene investigation to criminal investigations by highlighting the skills specific to scene practitioners which make them valuable to the overall investigative process. Examining scene investigation conceptually affords the opportunity for a robust understanding of the core principles that not only underlay the discipline, but also drives it.

Chapter Four — Methodology: Crime Scene Research Through Freedom of Information Requests

Freedom of information legislation as a data collection method for sociological, criminological and forensic science research is in its infancy, however, the methodology is formulated with the awareness and understanding that complementary to the appropriateness of the method pertaining to the subject-matter. It is a novel opportunity to examine the dynamics of FOIL as a method for social research, and to contribute to the literature on the subject. The evolution, current standing, advantages, disadvantages, triumphs and failures of FOIL are examined in considerable detail. Specific studies, and the FOIL in multiple jurisdictions were given attention. The types of data that such enquiries may yield were also considered.

The chapter highlights the importance of understanding the composition of the crime scene practitioner workforce, its size, and the costs associated with its operation, in comparison to laboratory-based investigations. FOIL holds great potential in such enquiries, and as such the 43 requests made to police forces in England & Wales, and one each to Police Scotland, and Police Service of Northern Ireland are explained.

Chapter Five — Going by the Numb3rs: The State of Crime Scene Work, and Scene Practitioners in the United Kingdom

The collected data is analysed with consideration to the key political and institutional changes over the data collection period. The most significant of these are the closure of the Forensic

Science Service (FSS), and austerity measures implemented by the Conservative government. The chapter answers critical questions posed in previous chapters, such as, the perception of crime scene personnel (their essential and desired characteristics), their responsibilities as expected by police forces, and their perceived roles within police organisations. The data correlates spending patterns with scene examiner numbers to analyse the impact of austerity on the same. It also distinguishes between the many designations assigned to crime scene personnel, mainly the differences (if any) between examiner, investigator, and Scenes of Crime Officer (SOCO), and attempts to construct a generic role profile that can be used universally.

It also analyses and presents financial data and scene practitioner numbers to present an idea of the overall size of the crime scene practice market in the United Kingdom. Additionally, the overarching aspect examined in the chapter is the state of knowledge management systems in police/law enforcement organisations in the jurisdiction(s) and the principal shortcomings and barriers to data collection and analysis with in relation to FOI and knowledge capture, storage, and dissemination with regard to scene practice in these bodies.

Chapter Six — Crime Scene Error Management: Mechanisms for Addressing Oversights

Quality control in crime scene investigation is a matter of contemporary academic and professional concern. There are very few comprehensive studies that have examined the subject in detail. This chapter elucidates on the developments in crime scene quality control, the current system in place, its pitfalls, and makes recommendations on possible schemes to improve the existing system. In the evaluation process, the chapter also formulates the underlying rationale behind quality control systems in forensic science, and quality assurance & quality control strategies.

Chapter Seven — Manual Labour or Scientific Work: Could Artificially-Intelligent Machines Replace Crime Scene Practitioners?

Forensic Science has seen several technological advancements in recent times. Crime scene investigation is no different. However, technological progress often brings with it concerns of deskilling and workers becoming redundant. Machines have been replacing several notable police positions, including forensic sketch artists, and with the advent of such technologies as image capturing robots, rapid DNA, and artificial intelligence, the future of forensic science practitioners could be at risk. This chapter examines the technologies (current, and developing) which can assist crime scene work, hinder the current status quo, and attempt to answer the complicated question: Can a machine do what a human crime scene investigator does, replacing the latter. It will also contribute to the literature on the sociology of knowledge, and examine the concept of technological change in the risk society, and technological determinism with regard to science and technology studies.

Chapter Eight — Future Directions and Considerations

The argument that crime scene work is not a mechanical and menial task is gathering steam, despite being a relatively new one. Understanding of the field is also improving with new knowledge emanating from academic research. This thesis introduces a novel conceptualisation of crime scenes as a non-linear, dynamic, complex system. It is the first of its kind to employ chaos theory, and systems analysis into an otherwise neglected segment of crime scene study. The perceptions, roles and responsibilities of scene investigators from a police organisational perspective are central to the thesis. Organisational insights of police forces in the UK as knowledge centres are extrapolated from data management practices reflected in freedom of information responses to understand the state of knowledge management in these organisations. Lack of uniformity in data labelling, storage and filing systems blight any effective knowledge-sharing. Crime scene personnel undertaking the same tasks in police forces are classified in a variety of role labels, despite responsibilities being largely homogeneous. A new data management strategy with uniform practices in record-keeping and labelling can be advantageous for police forces to share financial and performance data with the government, and each other.

Understanding of quality control, and quality assurance practices in scene investigation can benefit from this thesis, as it employs an all-encompassing approach to current systems and how the can be improved. Advancements in technology can better efficiency and productivity, but on the other hand, they may contribute to deskilling and eventual redundancy of human scene personnel. To protect the interests of scene practitioners requires the establishment of organisations which can help to professionalise the discipline. Professionalisation can also contribute to better standards and create a culture of knowledge-sharing and overall betterment. Police awareness and acknowledgment of the complexities and skillset involved in scene work can improve workplace relations between scene examiners and their police counterparts. In turn, knowledge of the boundaries of their own responsibilities can improve the work scene examiners do.

Starting at the Beginning

This thesis will start with a conceptualisation of crime scene work, based on its development through history, the obstacles which prevented its inception and progress, and its many facilitators. These will contextualise the modern institutions which have taken over from obsolete bodies and traditions, and help to identify those institutions and values which are essential to scene practice, and its continued existence.

CHAPTER TWO

In modern times, society has increasingly powerful reasons for understanding the sciences (Bodmer, 1986). Its influence on the technologies that shape everyday living is extensive and can be expected to grow (Erickson, 2016). Despite the understanding of the natural sciences not depending on the powerful political, economic and social forces which advance the enterprises producing it, inquiry into the methods enabling it to have a fact-stating capacity is significant (Jasanoff, 2011).

Since the nineteenth century, sociologists and anthropologists have undertaken studies into the crime, criminality and its enforcement in the same manner that they study all other societal activities. The sociology of scientific knowledge only differentiated itself from contemporary positions in the philosophy and sociology of science since the 1970s (Ashmore, 1989; Barnes, 2013). This new position insisted that scientific knowledge itself had to be understood as a social product and had to be empirical and naturalistic (Ginev, 1997). The manner in which scientific knowledge is capable of being social may be explored through studies of the past and present of the discipline.

Despite several attempts by scholars to plot the evolution of forensic science through the framework of sociological analysis, especially its origins, challenges, controversies and futures of technologies such as fingerprinting, DNA analysis (Lynch et al. 2010), bite-mark evidence (Vale, 2005; Dorion, 2016), and the forensic method (Saferstein, 2013) — crime scene investigation has been fairly neglected as a scholarly discipline. There could be several reasons for this. Firstly, crime scene investigation is often (incorrectly) considered to be manual work, with little to no basis in science (Crispino, 2008). On the other hand, the consideration and recognition of forensic science's value to socio-legal studies is a fairly recent development (Jasanoff, 2009), and due this inherent newness, crime scene literature may be understandably limited.

Historic records indicate that documentation of crimes throughout time has typically focused on homicide (Roth, 2010; Spierenburg, 2008). The amount of professional and public attention reserved for this form of criminal conduct in comparison to its non-homicide counterparts is cogent. The seriousness of homicide in both legal and religious contexts qualified it as the fitting project for historians of various eras to record every aspect of its investigation and prosecution. The recordability of such crimes lends significant value to social science inquiries. Conceptual and operational modes of historic investigations form useful sources of knowledge and precepts to the developmental steps in the systematic formalisation of the forensic method.

Criminal justice research in historical contexts, has focused on how current systems came to be, and what contributed to their current state (Pfohl, 1994; Terrill, 2007; Langbein et al. 2009;

Knepper & Johansen, 2016). These include the circumstances which advanced the formation of institutions for responding to crime, the functions of the institutions and actors associated with the same, the comparison or evaluation of their present state, and the experience of criminal justice against aims and objectives the founders earmarked for these establishments. In contemporary Western societies, police, courts, and prisons function together as components of the criminal justice system, but this was not always the case (Lacey, 2007; Binder et al. 2008).

Organised law enforcement is only a recent innovation, and legal systems with robust evidence consideration policies are also quite new. And, that provides a basis for analysis. An important question facing anthropologists, sociologists, and criminologists is the manner in which the earliest preliterate societies survived and maintained peace and order without written codes of law (Roth, 2010). Little is however known of how physical evidence was treated, or the value or otherwise attached to it, before the late-nineteenth and early twentieth century. Legal traditions had, for centuries placed greater emphasis on witness testimony than on the physical remnants or the space in which the crime had occurred. There are several attributable reasons for this, such as religion, and its effects on the limitation of scientific thinking (which often credited divinity to earthly phenomenon). Contemporary developments in law enforcement progression, during the scientific revolution can be a systematic indicator of this.

However, charting the history of punishment in society starts with critical observations of modern-day practices (Garland, 2014). Historians work backwards to trace the pedigree of contemporary institutions; and record the decline or emergence of present practices out of past events. As such, the history of the present, particularly in historical criminology, in which the objective is to instigate evaluation of policies and practices, holds considerable value. This has not been seen often in sociological literature surrounding crime scene investigation.

It could be attributable to a number of factors. One challenge with plotting responses to crime in the past as a collection of trajectories or pathways to the present is the quandary surrounding institutions or practices which did not survive (Braithwaite, 2003). An example of this, is the acceptance of and preference to torture-induced confessions by the judiciary as a primary source of evidence. The history of punishment also involves a slew of institutions and practices that may not have representation or existence in present times. This can be seen in research surrounding prison systems (Meranze, 2003) and on the death penalty (McGowen, 1987; 1994).

Despite considerable efforts in mapping the advancement and enactment of specific forensic techniques, historians have paid limited attention to crime scene investigation as a separate subject of inquiry. Scene work is sporadically referenced in texts without any attempt to outline their basis, or as a system that is entrenched in a network of institutions, concepts and practices. The absence of such analyses leaves a body of work that focuses on practitioner accounts and

biographical studies of eminent nineteenth and twentieth century figures without alluding to the significance of the events leading up to that period. Crime scene investigation, like every other social phenomenon came into existence for a reason, or as a response to a necessity within society. Due to a lack of strategy to analyse socio-legal developments with the objective of finding rationale for the inception, and development of crime scene work, the field has endured sluggish progress.

The development narrative of forensic science has thus remained incomplete. Crime and its punishment are among the oldest problems faced by mankind. Historic records of crime detection and criminal prosecution by historians and other actors is available from the twenty-first century going back to ancient times (Wileman, 2015). The challenge in identifying forensic science and by extension, forensic detection in such narratives is the non-formalised nature of the discipline, in antiquity. Science, in its current form, was not understood or recognised in societies of the past. Therefore, a review of literature surrounding crime scenes could lend a definitional understanding of the discipline and assist in a historical review of the legal, and law enforcement working practices/system(s) it replaced.

Delineation of Crime Scene Practice

Despite there being some disagreement between the nature of the work, it is generally understood that forensic science is the all-encompassing umbrella under-which, crime scene work is categorised. The former can be divided into two broad categories (Forrest & Kennedy, 2012). The first concerns the methodology and techniques of traditional academic scientific disciplines to solve questions stemming from criminal matters. These disciplines utilise established research, experimentation and validation techniques using the scientific method (Quarino & Houck, 2008). The second represents those disciplines that have developed solely from the needs of the law to establish connections between evidence and/or between persons through interpretation of observable patterns for use in criminal cases (Page et al. 2011). They deal with forensic identification or individuation, such as matching a suspect or inanimate object to an item of evidence in the case.

In most contexts, forensic science begins at the crime scene, and its principal aims are recovery and analysis of physical and chemical traces left at the scene (Julian et al. 2012). Evidence identification, interpretation and recovery at the crime scene is the essential first step in forensic investigations (White, 2010). Derivative members of the forensic science community are members who undertake this work — crime scene examiners/investigators, popularly referred to, as CSIs, CSEs or Scenes of Crime Officers (SOCOs). Arguably, more than any other members of the wider forensic science colony, crime scene examiners face the toughest task of establishing that their work is scientific (Millen, 2000).

Questions surrounding the credibility of forensic methods, techniques and results means that every aspect of the crime scene to crime lab workflow process requires close examination. The vast majority of forensic science literature bills crime scene investigation as a key component of the practice (Julian et al. 2012). Despite the discipline (as a whole) striving for legal and scientific validity, fitness for the purpose, and investigative integrity, scene examiners and their work is broadly overlooked.

Crucial aspects such as the nature of crime scene work, the techniques used, and the professional identities of scene investigators carry paramount relevance in constructing the base on which the forensic sciences stand. Scene assessments facilitate the coordinated identification, collection, and storage of physical evidence and identification of witnesses (O'Hara & O'Hara, 1956). It also affords the exchange of information among law enforcement personnel and the development of investigative strategies (Ribaux et al. 2010a; 2010b). This involves a complex step-by-step procedure, which requires crime scene investigators to undertake a myriad of police and non-police functions.

The investigator(s) in charge of a scene are have to identify specific responsibilities for team members, relay preliminary findings, and flesh out investigative plans in line with departmental policy and the law (Millen, 2000). It follows with interviews of first-responding officer(s) about their observations and activities at the scene, so that the known facts of the case can be documented, and any contamination that may have occurred can be identified (Genge, 2008). The scene is then evaluated from a safety perspective. The investigator's assessment will be based on consideration of all possible biological, and non-biological hazards at the area (Pepper, 2010).

Once the scene is determined to be safe, scene investigators address search and seizure concerns, particularly legal requirements to obtain consent and permission, or a search warrant for the property (Dutelle, 2014). They then formulate and establish paths of entry and exit to and from the scene for authorised personnel, demarcate scene boundaries, and prioritise areas based on importance (Gruijter et al. 2016). Secure areas are chosen and appropriately set up close to the scene so that consultations between various members of the investigative team can take place, there is area for equipment staging, and where evidence can be stored temporarily (Sutton et al. 2016). At the same time, investigators are tasked with ensuring scene integrity, which includes documenting entry/exit of authorised personnel, and restricting unauthorised access (Burney & Pemberton, 2013).

In order to get an overview of the whole scene, investigators do walk-throughs, which allow for an initial chance to identify important and/or fragile evidence, setting up appropriate procedures for a systematic search and efficient recording of the scene (Fish et al. 2013). The priorities at

this stage are to avoid contamination through use of established paths of entry and planning initial documentation of the scene as it is observed. If it is ascertained that any evidence has been compromised, it is recorded, photographed and collected right away.

Scene work has been claimed to be concerted scientific and investigative undertakings, its success requiring utilisation of experience, creative thinking, logic, and the correct application of science and the scientific method (Shaler, 2011). The meticulous and diligent examination and recording of the crime scene is stated to be of monumental importance to criminal prosecutions (Pepper, 2010). Inadequately managed scenes have been suggested to result in poor quality evidence collection and raises the risk of unsuccessful investigations and even wrongful convictions (Edwards, 2005).

In the past, endeavours at the crime scene were viewed merely as 'police work' and, processing and managing the crime scene was seen to be a technical discipline (Crispino, 2008; Millen, 2000). However, crime scene investigation and its practitioners have received significantly greater attention in recent years. There are several mainly court-driven (Ratcliffe, 2008) drivers for this: an increasing reliance by the courts on forensic evidence for identification purposes (Shelton et al. 2007); the so-called 'CSI effect' and resultant expectation by the prosecution (Wise, 2008) and juries (Goodman-Delahunty, 2009) that forensic science evidence will be introduced as part of the prosecution case; and the recognition of the potential value of forensic evidence for intelligence and investigative purposes (Julian et al. 2011). It cultivates queries about what is collected at crime scenes, for what purpose (Ribaux et al. 2010a; 2010b), who crime scene investigators are (Wilson-Kovacs, 2014), and the techniques and technologies associated with this work (Gruijter et al. 2016; Nordby, 2012).

At the core of the discipline lies the responsibilities of scene examiners to identify, collect and store biological and non-biological samples for scientific analysis. There is debate surrounding whether crime scene investigation is itself scientific (Houck et al. 2017; Julian et al. 2012; Lyman, 2001). However, there is far less controversy regarding what it potentially leads to. Without the ability to measure, compare, correlate and link articles of evidence, or samples, the purpose of scene investigation, and/or in rudimentary terms, the collection of physical evidence would add little value to criminal prosecutions. For example, it would be pointless to collect a knife at a murder scene with a set of fingerprints on the handle, if there is no way to lift the prints, test them against known or unknown suspects, or even determine whether a knife was at all the implement used to injure the victim. The knife could be tested for DNA, the blood on the handle and the blade can be typed, and impressions of the wound could determine whether it was the murder weapon. Additionally, DNA and fingerprint databases could be utilised to

identify potential suspects, or forensic intelligence systems could point investigators to similar crimes in or around the area.

Crime scene investigation can thus lead to scientific and technological analysis of items collected at the scene. In modern times, scene investigation has become a staple of criminal investigations, in the real world, and also in society's perception of the investigative process. Public fascination with criminal detection and forensic investigation is both historic and unyielding (Gabel, 2010). The process of narrative reconstruction of crimes through these means has been said to involve dexterity and self-discipline (Fish et al. 2010).

At its core, crime scene practice has a robust kinship with physical evidence (Lee, 2001). The underlying rationale for accurate and contemporaneous documentation has a lot to do with courts, for years, being subjected to the fallibility of human memory. The believability of eyewitness accounts, confessions, and informant testimony can be disputed, maligned, and subjected to attack and scepticism in the courtroom. Under these circumstances, errors in human judgment are often magnified by lawyers to detract from the credibility of their witness (Saferstein, 2013).

In order to demonstrate the potential unreliability of human memory, Roediger & McDermott (1995) presented research participants with a list of twelve words (e.g., "bed", "rest", "awake") and immediately asked them to remember as many words from the list as possible. On average, participants were able to recall 65% of the words. 40% of participants remembered seeing a word that had not been listed at all – the word "sleep". Confidence in this false memory was also found to be remarkably high. It was reported that the respondents' introduction of "sleep" was not coincidental, instead being a consequence of thematic associations with the other words.

Questionable memory has been a concern in criminal prosecutions for a number of reasons. The Innocence Project (2016) estimated that 72% of wrongful convictions are associated with failures of eyewitness memory. They reported the case of Ronald Cotton, who was convicted of rape and burglary in 1985 based primarily on the testimony of the victim, Jennifer Thompson. Thompson stated that she had made a deliberate effort to remember as much as she possibly could about her assailant and gave the police a detailed account of the attack. At the photo-line-up, she stated with absolute confidence that Cotton was the man who had raped her.

However, Ronald Cotton was innocent, and served 10 years in prison before being exonerated by DNA evidence in 1995. It was one of many such cases of wrongful conviction and exoneration and is a caustic example that memories can be unreliable despite deliberate effort to remember. Even if a person attempts with diligence to commit details to memory, with a high level of motivation to remember, having full confidence in the accuracy of the memory —

errors are inexorable. Psychologists have found that memory errors can, and often do, occur in any of the three stages of memory. Errors occur during the event (encoding), while the event is stored in long-term memory (storage), and when the memory is recalled later (retrieval) (Klatzky, 1975).

Therefore, a reliance on physical evidence has been the focus of criminal justice systems in modern times (Houck, 2009). Tangible evidence can take a multitude of forms, which include objects, documents, sensor images, measurements, and representations such as charts, graphs, maps, and diagrams. These are open to inspection, but their relevance and value are often not apparent on the face of the evidence itself. The principal concern surrounding such evidence is its reliability. Documents have been known to be forged, currency counterfeited, images labelled incorrectly, biological samples contaminated, and objects such as drugs planted on persons. There are therefore a number of issues that should be considered in assessing the credibility of tangible evidence.

Authenticity is the most significant element of this category (Imwinkelried et al. 1979). In legal contexts, the side looking to introduce a document, photograph, or another item of tangible evidence must offer evidence that purports to be what is relevant to a penultimate probandum or to the credibility of other evidence in the proceedings (Gardner & Anderson, 2015). There are three main arguments that may bring into question the authenticity of tangible evidence (Twining, 2003) — (i) evidence that has been deliberately contrived in order to mislead others; (ii) evidence which contains recording, transmitting, or processing errors, in that, evidence which has not passed through an established chain of custody from the time it was discovered or generated until the time it is introduced in court; and, (iii) the witness whose testimony is offered to establish the authenticity of the evidential artefact is mistaken or untruthful.

Accuracy is another important facet of the credibility of tangible items of evidence (Roberts & Zuckerman, 2010). Technological devices in modern times provide tangible evidence in the form of images, measurements and representations of every element of the crime, including the approximation of the circumstances of its occurring. Credibility in this context relates to whether a sensing device provides the degree of accuracy necessary for the court to determine the possible events that may be discerned from the representations.

A reliable process for legal purposes can be described as one that is repeatable, dependable and/or consistent. Reliability can relate to the operating characteristics of the device used to generate evidence. Devices/tools are reliable only if it gives the same reading or representation on repeated applications of the device. The term, in statistical analysis refers to the extent of measurement error that is naturally associated with any statistical estimate.

Reliability in forensic evidence is often linked to its basis in science (NAS, 2009a). The term has evolved over the course of history, and while there are arguments that courtrooms have entertained pseudoscience and often 'bad' science, the advent of forensics has seen the establishment of methods and practices that have largely held up to logical challenge (Shelton, 2008). Contemporary societies have however, demonstrated an overall eagerness to incorporate scientific knowledge into their lives (Hayek, 1945), for a number of reasons, beyond criminal justice or forensic science. However, a return to confession and testimony-based adjudication would also not be feasible.

One reason behind the seemingly late arrival of crime scene practice and physical evidence use in courts could be the high expectations placed on it. The central ideas of scene investigation and the evidence collection process are associated with the contributions of Hans Gross and Edmond Locard (Cole, 2012), however, the discipline owes its development to over two millennia of history. Commentators often refrain from including past events in their analysis of the roots of forensic science due to a narrow classification of forensics itself (Bell, 2008). The scholarly efforts of historians and social scientists on the development of the forensic sciences is substantial. However, works devoted to tracing the significant occurrences in antiquity that had a developmental effect on forensic science as it exists in modern times is limited.

Understanding Evidence & Proof in Criminal Justice Contexts

An underexamined area is the developmental history of evidence. Despite inferential reasoning, evaluating and weighing evidence, forming judgments about the past, present or the future, being a constant, necessary, and arguably essential facet of societies (Anderson et al. 2005), knowledge surrounding the enactment of reason to criminal disputes is limited. It has been found to be a central aspect of crime scene work, and employment of cognitive reasoning is where crime scene investigation begins (Baber et al. 2006).

The result of reasoning, inductive and deductive at crime scenes often results in collection of artefacts, referred to, when produced in court, as evidence. Throughout society, the value of evidence can be seen in almost every discipline or practice. From medical professionals (Evidence-based Medicine Working Group, 1992; Sackett et al. 1996; Sackett, 1997), educators (Davies, 1999; Slavin, 2002; Horner et al. 2005; Aikenhead, 2006) and policymakers (Murray & Lopez, 1996; Nutley et al. 2000; Pawson, 2006), evidence-based practice is a recurring theme in academic and policy literature. All disciplines, from archaeology to zoology, from history to astronomy, from statistics to decision theory, share the commonality of evidence consideration and inference (Twining & Hampsher-Monk, 2003).

In criminal justice contexts, evidence holds undeniable value (Ribaux et al. 2017), notwithstanding the challenges of ascertaining the extent of its usefulness to courts (Julian et al.

2011). The use of physical evidence in court to establish guilt or innocence brings into collaboration two institutions with considerably varied aims and normative commitments (Jasanoff, 2006). Simon (1967), Strodtbeck et al. (1957), and Strodtbeck & Mann (1956) examined the deliberations of 40 mock juries and concluded that their deliberations prominently relied on the details of the case, appropriate weighing of the credibility of witnesses, and their verdicts were reached through consideration of the evidence. Similar studies were undertaken in England, where researchers enlisted participants from local jury pools who had either sat in on an actual trial (McCabe & Purves, 1974), listened to an audio tape (Sealy, 1975), or viewed a video re-enactment (Hastie et al. 1983) of a criminal trial. Analyses showed that a high percentage of total deliberation time was devoted to relevant evidentiary considerations.

Evidence, therefore, can be argued to have a prominent standing in the criminal justice system and in the outcomes of legal disputes. However, little is known about the origins of evidence in this context. Unlike literature on the philosophical origins of the basis of evidence in medicine (Sackett et al. 1996), the historical underpinnings of evidence in criminal investigative practices is largely unexplored.

Legal historians note that the "beyond reasonable doubt" standard that has characterized the Anglo-American criminal justice system for over two centuries carries socio-legal value (Shapiro, 1991). Criminal cases are distinctly different from civil proceedings, in that, the former has harsher punitive sanctions and as such, a higher degree of proof on the part of the prosecuting authority (Jeffries & Stephan, 1979; Clermont, 2008). Proof in itself, has undergone dramatic changes over course of the last millennia. An examination of these developments can assist with an overall understanding of the place of physical evidence in modern criminal justice systems. In conjunction with the advancement of socio-legal, and medico-legal traditions, scientific developments and enactment of knowledge systems through institutionalisation of law enforcement, insight can be gained as to the value of evidence-based criminal adjudication and the alternatives that were explored before its establishment.

Developmental History of Proof

The earliest known ideas of proof and its place in crime and punishment stem from the so-called irrational proofs in trials by ordeal before the Norman conquests (Shapiro, 1991). The Romano-canon inquisition system afforded a mechanism of inquest presided over by judges (Shapiro, 1994). It was devised to obtain "full proof" defined by set evidentiary standards which clearly earmarked the quality and quantity of proof. A set number of witnesses were needed to establish facts, and once the required "full proof" had been found, conviction was automatic (Shapiro, 1991). The judges in these criminal cases essentially performed the duty of

totalling the proof fractions. The cases called for two good witnesses or preferably a confession. As confession was of high evidentiary value, torture was used to induce it. The rules that determined whether there was enough evidence to justify judicial torture, were complicated and cumbersome. For centuries, legal systems relied solely on a combination of confession, and witness evidence without the need for other forms of evidence to sentence the accused.

For over a millennium, witness testimony and confessions were the preferred means of adjudicating disputes and punishing wrongdoing (Briggs et al. 2005). In trial by compurgation, during the Middle Ages, the jury or juratores (those sworn) were summoned to swear to the truth of the submission of the defendant, or petitioner. They did not do so on the basis of any evidence introduced in the court but of their knowledge of the disputants and the alleged offences. It was essentially a type of arbitration with an inclination to compromise — even in criminal cases.

The writs of novel disseisin (recent dispossession) and mort d'ancestor (death of ancestor) were another form of adjudication, which used de facto trial juries for reaching decisions concerning land disputes (Morgan, 1922). These were later adapted to criminal cases as well, thus giving birth to trial juries. Criminal cases utilised juries of presentment since their establishment in 1166 (McRae Jr, 1948). They comprised of local men under oath who decided the truth of a criminal charge against a person by the juries of presentment or other means. The most important characteristic with regard to this chapter, is that that these trial juries reached verdicts not on the basis of evidence presented to them in court, but on the basis of their knowledge of what had taken place — which, in modern times would have disqualified the jurors from being drafted for trial (Briggs et al. 2005).

As time progressed, assizes (periodic courts or intervallic judicial inquests) became the successors of the medieval eyre (circuit court adjudicated by a traveling judge), which brought Westminster judges to the shires to hear Crown pleas both civil and criminal (Musson, 2001). By the year 1337, England was divided into six circuits. Each circuit, consisted of contiguous counties, which were visited by two Westminster justices (Cockburn, 1968).

One heard the civil suits while the other, the criminal cases. They had the power to hear cases of treason, felony and misdemeanours and to try prisoners in gaol upon their arrival. The local constable brought the charges on behalf of the community. The prisoner had to enter a plea, but often did not do so to prevent the state from confiscating their property. The rules stated that if one did not plead, he/she could not be convicted. If not convicted, a suspect's land could not be seized by the Crown — the only means of ownership transferring to the Crown was from convicted felons.

The accused refusing to plead were taken to be pressed to death in a procedure called peine forte et dure (Montrose, 1959). They would be stripped, placed naked on rocks and soaked with cold water. Then a board would be placed on top of him and rocks stacked on the board. The number and weight of rocks would be increased until the accused either entered a plea or died.

Witnesses for the prosecution were sworn and provided evidence, while defence witnesses were only allowed to give unsworn evidence. If charged with treason or felonies, individuals were not permitted to be legally represented. Their only recourse was to question witnesses and make what they could from the answers against the charges brought on them. The verdicts of the juries were given in open court, and sentences announced by the judge(s) at the end of the day.

Justices of the Peace (JP) acted as law enforcement in the roles of superintendents, keeping others up to scratch (Putnam, 1929). They oversaw the imposition of the Poor Law, appointed officials such as parish overseers of the poor, evaluated Poor Law accounts, sanctioned parish poor rates, presided over disputes, and heard appeals against overseers' decisions (Herrup, 1989). This system of law enforcement and legal adjudication are particularly relevant to contemporary critical criminology studies. The unequal distribution of power and material resources within societies provide a unifying basis for all branches of critical criminology (Carrington & Hogg, 2008; Taylor et al. 2013). In modern societies, critical criminologists examine such policies as “zero-tolerance” policing (e.g., criminalizing incivilities like panhandling), three-strikes sentencing, private prisons, coercive counselling therapy, and so on. In the past, particularly during the time of the Justices, these inequalities and coercive practices were commonplace and formed societal norms.

The Justices’ were tasked with taking evidence from the complainant and witnesses. Once satisfied, they would hand over the oral accounts and collected evidence to the court officials. The documents formed the basis of the court's assessment.

Until the eighteenth century, the only discernible substantiation that physical evidence was a factor in deciding criminal trials was a development in 1194, under King Henry's son Richard I (1189-99). County officers called coroners were appointed to work with a sworn jury to inquire into all sudden and unnatural deaths and report back to the Crown. If a serious offence such as homicide was alleged, the coroner was under duty to alert the sheriff, who then would arrest and imprison the accused until the next eyre. It was a mechanism set up to make sure that all serious crimes were brought to the attention of the court (Songer, 2016).

This increased interest may not have been justice-driven, though. The Crown, under the rules was entitled to the value of the item that had caused the death (called the deodand) whether or not it had been a murder instrument, such as a sword, or a non-murder instrument, which accidentally had caused the death. For instance, if a wagon or cart collapsed and killed

someone, the Crown was entitled to the value of the objects and the beasts (horses or oxen) that were attached to the instruments at the time (Butler, 2014). The rationale for the collection, and/or seizure of weapons or tools used in criminal conduct does not align with present day motivations for presenting physical evidence at trials. Before the eighteenth century, property such as those involved in the commission of an offence were seized by the Crown, as an additional instance of punishment for the accused. The rationale, on the face of it, would appear to be more economic, than for the assurance of justice. There was very little basis for physical evidence use at trials, but the body, if there was a homicide, held value even in past societies. This was a specific choice by English courts to place its reliance on findings emanating from the body, rather than from the space where the crime had occurred (Burney & Pemberton, 2013).

As the philosophical underpinnings of the Romano-canon system stemmed from medieval scholastic philosophers, with the system becoming well-entrenched on the continent during that period, it appears to have been relatively uninfluenced by the epistemological issues that became acute in the early modern period, such as an increased concentration on the sources, nature, and limitations of human knowledge. Use of expert knowledge was however not understood to be a useful resource. The idea of the expert witness was not introduced until much later, and with the passage of the 1836 Medical Witnesses Act statutorily entitled to payment for their services (Fisher, 2007). This idea of court-appointed, or court-summoned witnesses assisting the judge(s) and jury with factual matters directly relates to scene practitioners, who are, in the UK, termed as expert witnesses in the courtroom.

The Conceptualisation & Adoption of the Expert Witness

Crime scene practitioners are usually required to report to the court with their findings, and to testify in criminal proceedings (Horswell, 2004). They are classified as expert witnesses. In the UK, an expert is entitled to give opinion evidence only on relevant matters which are within their area of expertise and beyond the general knowledge and understanding of the tribunal of fact (usually the jury). The test makes sure that irrelevant evidence is not entertained and upholds the notion that questions of fact should be left to the jury, to the standard imposed by law, and not by witnesses according to their own subjective standards (Emson, 2004). This was not however, always the case.

Despite documented records from the sixth century AD, when the Roman emperor Justinian (525-564) had recognized the importance of expert witnesses, declaring that physicians were not ordinary witnesses but persons who gave judgments rather than testimony (Wood & Guha, 2001) — a lot was lost during the Dark Ages, resulting in almost a restart of knowledge production (Grant, 1971). There was progress in Italy as far back as 1209, when Pope Innocent

III enlisted medical-men to perform post-mortems for the purpose of establishing the nature of various types of wounds in legal matters. Italy, specifically at the University of Bologna, was also the first country in which legal medicine was recognized as a specialty (O'Neill, 1976). The decretals of Innocent III contain multiple instances where medical findings provided the evidential basis for a papal verdict (Prioreschi, 2001).

For much of the eighteenth and nineteenth century, witnesses were not selected on the basis of special skill or experience, instead being chosen on proximity to the death in question—either by virtue of having been the deceased's attending practitioner or, failing that, being at the time in actual practice in or near the place where the death had taken place (Burney, 2000).

In 1832, chemistry was first used as evidence in an English case of arsenic poisoning by sampling the lining of a victim's stomach (Gorby, 1988; Yeatts, 2001; Yount, 2007). Just as the O.J. Simpson trial played a crucial part in establishing DNA typing as a major tool for forensic detection (Lynch et al. 2010), the Marie LaFarge case was the high-profile media spectacle that launched forensic toxicology eight years later (Lappas & Lappas, 2015).

In France, in 1840, the developing science of toxicology was tested by a memorable murder trial. Rumoured to be in an unhappy marriage, 24-year-old Marie Lafarge was charged with the poisoning of her husband Charles. Witnesses claimed to have seen her purchasing arsenic (she claimed it was to kill rodents). There was also testimony that she had stirred a white powder into Charles' food. The prosecution introduced the findings of local doctors who had run chemical tests on Charles Lafarge's stomach and on the white powder that had been collected from the house as evidence. This was a prominent example of the collection of physical items of evidence for judicial purposes, and a prelude to the realisation of the value of crime scene investigation.

Lafarge's lawyer refuted the scientific techniques and competence of the prosecution expert witnesses, who were unfamiliar with the improved test for arsenic formulated by English chemist James Marsh, four years prior (Wennig, 2009). Lawyers from each side cross-examined the doctors, and eventually doubt was cast on their methods, results and interpretations. The judge in the case ordered exhumation of Charles Lafarge's body so that further tests could be performed. The initial tests presented no evidence of arsenic, but was refuted by new chemical analysis of the food. Newspapers provided an array of coverage, making the Lafarge trial a media spectacle (Stefoff, 2010).

Eventually, the two sides agreed to consult the highest authority on the subject, Mathieu Orfila, an eminent professor of forensic medicine, and the most respected authority on toxicological matters of the time. Orfila applied the Marsh test on samples from Charles Lafarge's corpse and soil at the place of burial. He found definite traces of arsenic in the body and showed that it did

not come from the surrounding soil. The defence's final strategy was to summon yet another expert witness, François Raspail, Orfila's bitter enemy, who had already grappled with him in a previous case.

The court however found LaFarge guilty of murder and sentenced her to death. It was subsequently commuted to life in prison, but the outcome received less publicity than the process. Orfila's confirmation of the Marsh test was publicly revelled as a vindication of forensic science, while Raspail and his supporters declared that Orfila's analysis was faulty, maintaining Marie Lafarge's innocence.

The LaFarge trial was however, a landmark moment for use of scientific evidence at trial. Orfila's dramatic and then famous testimony as a recognized expert in forensic toxicology marked the beginning of courtrooms allowing scientific evidence and expertise within its walls (Thomas, 1974). In a trend repeated today (the CSI effect), students studying chemistry vied for the chance to study with Orfila and to become forensic toxicologists themselves. Prosecution and defence counsel realized that scientific analysis of evidence could be the crux of a case or the undoing of it rather than an afterthought. Orfila's testimony and the acceptance of the Marsh test did not end poisoning, nor did they do anything to prevent accidental exposures to arsenic. Eventually that would come, but as is often the case, the scientific advancement aided law enforcement and also forced murderers to alter their tactics.

The LaFarge trial did provide a landmark platform for use of scientific evidence at a criminal trial. The sensational nature of the case, the central role of science, and dramatic testimony from competing experts, paved the road for courtrooms to entertain scientific evidence and expertise in legal proceedings. This trend of warring experts, competing scientific hypothesis, and the courts allowing it, has become a staple of modern criminal justice systems (Giannelli, 1993; Jasanoff, 1995).

Even though collection of articles of evidence from scenes of crimes was happening more frequently, formalised crime scene investigation was still not present until the early twentieth century. Police agencies and death investigators adopted crime scene photography in the late 1800s, due to advancements in the technology of photographic capture, and realisation of the value of providing visual cues for jurors, or judges to assess the case before them. This was another innovation that was adopted by the courts during a time when technologies facilitating crime scene work were entering the fray.

Documentation using early photography, particularly daguerreotypes (also informally called tintypes), was tedious and not well suited to the transitory nature of crime scenes. The method was used for criminal identification, with one of the earliest known mug shots being daguerreotypes from Belgium taken in 1843. By 1854, the Swiss had also used mug shots.

Once simpler methods using negative plates were developed and commercialized, crime scene photography was used, but not universally. Few of the earliest and more famous examples were crime scene photos taken in London in 1888 as part of the Jack the Ripper case. Legal acceptance of photographic evidence from crime scene to photomicrographs occurred in the late 1800s in Europe and in the United States, with experts called in to testify as to the authenticity and content.

As coroner's inquests became more prevalent, investigations began to extend beyond the body — only slightly. In the nineteenth century, medical witnesses began collecting blood samples from around the body and included it as part of their examination (Burney & Pemberton, 2016). However, due to a lack of scientific basis to compare one blood sample to another, and determine uniqueness or similarity, blood evidence was used only as a marker for assisting investigators in figuring out the circumstances of the crime.

For example, blood on weapons, hair and other substances on weapons, foreign substances in wounds, marks of blood on clothing or furniture, marks of blood or other substances on the deceased, and marks of blood on the assailant were all tools that served as clues for investigators to piece together, with the help of the coroner to ascertain the possible events that led to the commission of an offence, and/or who the perpetrator may have been.

This was the case, until blood as an artefact of forensic analysis was introduced as a method for identifying individuals suspected of committing offences in the twentieth century (Harbison, 2016; Innes & Singer, 2016). By 1937, more than 100 antigens and twenty-three different blood groups based on the presence or absence of those antigens had been discovered. Thirty years later, experts had gained the ability to utilise blood typing to exclude individuals as the sources of blood samples, providing a statistical probability. For instance, if B-type blood was found at the crime scene, the expert could merely state that a suspect with O, A, or AB-type blood did not leave the sample, and that the blood could have come from any person with B-type blood, which accounted for, at the time, ten percent of the overall population. Blood-typing, therefore, could help prove innocence, but they could not be used to assist in the identification of suspects beyond a reasonable doubt — the necessary standard for securing a criminal conviction.

By the end of the twentieth century, scientists, police photographers and expert witnesses from various areas of proficiency were therefore, being allowed into court to testify as to the nature and value of physical evidence. Institutionalisation of law enforcement evidence collection and storage mechanisms can be attributed to this facilitation of knowledge exchange. Such institutionalisation of law enforcement science was a driver in installing forensic science practices, like crime scene investigation into police organisations. It can be credited to what Cordner & Scarborough (2010) referred to, as the development of police administration.

Importance of Organisational Drivers

Interpreted narrowly, policing can be described as the work of an organized police force, a disciplined, professional corps, whose duties include enforcing the law through investigation and prosecution and ensuring public order (Bayley, 1977). In antiquity, despite bearing several hallmarks of the modern system, it may be referred to as social regulation, or the role played by government in regulating the welfare, security, and order of a city. For example, Athens had a whole host of officials, for the most part annually selected boards of magistrates, each devoted to an aspect of social regulation (Lanni, 2016).

In those times, most of the principal responsibilities of policing—investigation, capture, prosecution, and even in some cases enforcement of court decisions—fell to the citizens themselves. Private initiative and self-help was the rule. Policing in this sense, whether the work of Athenian citizens or of the Scythians or other public slaves who supplanted them after circa 390 AD, is very much the concern of this work. At the heart of that system lies the practice of private prosecution (Rothchild, 2008). Thus, the crime of murder was not, legally at any rate, a public concern: a murderer was prosecuted by the deceased's next of kin, who initiated a dikx phonou, or right of prosecution (Porrello, 2008).

Without an organised police force, the most striking example of the use of physical evidence and the ancient roots of the concept of "chain of custody" can be seen in an ancient private prosecution practice. Both Athenian and Roman law used this rite for the discovery of stolen goods or property thought to be in connection with a crime. It is also one of the oldest instances of evidence search, discovery, collection, and submission for justice. The 'platter and loincloth' search as it was known, required the person conducting the search to walk virtually naked through the premises of the suspect, holding a platter in both hands (Brewer, 1984). The arrangement was to prevent him from touching any object and from carrying incriminating evidence into the house. It is entirely consistent with modern day motivations for enforcing a strict chain of custody surrounding evidence collection at scenes of crime. The old rationale was that if the lost object was present, it would reveal itself to its rightful owner. Clearly, this mode of search would have been most effective if the stolen property was a domestic animal that would recognize its master. How it had revealed inanimate objects is unclear. However, this is the closest parallel to modern day crime scene investigation that can be drawn from the ancient world, along with slaves canvassing scenes of crime and gathering physical evidence.

In England, a meaningful step was taken in the mid-eighteenth century by novelist Henry Fielding, who was chief magistrate of the London Bow Street Court and police office between 1748 and 1754. To better enforce the law, he created a small cadre of detectives who helped him in his judicial and investigative functions for the benefit of the public at large, at least

partially at government expense (Beattie, 2006; Beattie, 2012). His half-brother John Fielding, who succeeded him in this judicial role until his death in 1780, further cultivated the small coterie of about half a dozen men, who in time became known as the Bow Street Runners (Beattie, 2012).

Organized, paid, civilian policing as it stands today, began with the enactment of the Metropolitan Police Act 1829 (Critchley, 1978). Before this, law enforcement in England was the purview of volunteers, night watchmen, private merchant police, soldiers, personal employees of justices of the peace, constables, sheriffs, slave patrols, and ordinary citizens. This informal and unsystematic law enforcement structure had proved satisfactory for centuries, but was overwhelmed by the Industrial Revolution, that initiated rapid urbanization and out of control crime rates.

Sir Robert Peel was authorised by 1829 Metropolitan Police Act to set up a police force for the metropolitan London area, with 1,000 men brought on. From no organised police force, there suddenly existed an organization. The organizational and managerial problems faced by Peel and his police commissioners, Charles Rowan and Robert Mayne, were in essence the same as those faced by law enforcement in the twenty-first century (Emsley, 2014). Peel's solution was to implement the following reforms: (i) organisation of the police in along military lines; (ii) mandating the hiring and training of appropriate persons; (iii) employment of potential hires on a probationary basis, later leading to promotion; (iv) implementation of governmental control of the force(s); (v) allocation and deployment of police resources by time and area; (vi) establishing police headquarters in a central location; and, (vii) ensuring detailed record keeping.

It was decided that prevention of crime would be the main concerns of the police, along with order maintenance and the provision of various government services. Police were expected to prevent crime through diligent street patrols to deter troublemakers. Such patrolling was thought to create a sense of police "omnipresence," a sense that the police were everywhere, or could be anywhere (Hess et al. 2013). The early police did not devote a major portion of their time and resources to the investigation of crimes already committed, or to the apprehension of those responsible for committing serious crimes. Crime victims commonly offered rewards for the return of stolen property or the capture of assailants, and these rewards were largely the province of private detectives, informers, and, frequently, perpetrators themselves. There was a clear distinction between patrol work and detective work; patrol work was performed by the public police forces, while investigative work remained in the private domain. Gradually, however, the public police became more involved in crime investigation and criminal

apprehension, to the point that by the 1950s and 1960s the public's image of the police was that of crime fighters, a role which the latter gradually accepted.

The legal system began to seek greater adherence by the police to legal norms. Community norms were being replaced by these (Sykes, 1986). This inclined the police towards a focus on crimes, which were the clearest violations of legal norms. In addition, investigating crimes represented professionalism, as opposed to dealing with alcoholics, vagrants, and sex-workers (Cordner & Scarborough, 2010). The police could claim special skills as well as the need for special training for investigating crimes, much more so than for maintaining order. Special equipment and scientific methods were also part of criminal investigation and could be cited as evidence that police work was a profession. This development coincided with related advancements in forensic science, and in turn crime scene investigative techniques.

Acceptance of Science in Criminal Investigations & Prosecutions

Following Socrates' consumption of a fatal dose of hemlock in 399 BC and Hippocrates' (460-355 BC) discussion on lethal wounds and prescription of arsenic remedies, the earliest homicides by poisoning were recorded, introducing primitive attempts to explain what is now known as toxicology (Daugherty, 1995). Alexandrian physicians Eraistratus and Herophilus were credited for subsequent medicolegal inquries of wounds, poisonings, and other causes of death (Von Staden, 1989). In 82 BC, the Roman Republic passed the first law against poisoning and two decades later prosecuted a murder suspect, Cluentius, with the orator Cicero chosen to defend him (Hoenigswald, 1962). These were the earliest depictions of attempts to study events leading up to, or being the cause of crime by using concepts, such as toxicology and which in modern times has become mainstream.

Forensics, as it is known in the present, started to become a regular part of police work in Western societies at the end of the nineteenth century, after Austrian law professor, Hans Gross published a two-volume handbook on the subject in 1893 (Grassberger, 1956). Gross's book, referred to as *Criminal Investigation,* brought together all the many techniques that scientists and law enforcers had developed for examining the physical evidence of crime—bloodstains, bullets, and more (Gross, 1893). Police departments began using Criminal Investigation to train officers. The book entered law school courses with forensics specialists regarding Hans Gross as the founder of their profession. Among other contributions, Gross coined the term criminalistics, relating to the general study of crime or criminals. Criminalistics has since seen a narrower, more specific classification in contemporary times, pointedly referring to the collection, protection, and examination of physical evidence from crime scenes— collectively known as crime scene investigation/examination (Burney & Pemberton, 2013).

The first crime labs were established in the early twentieth century (Stefoff, 2011). As knowledge of criminalistics and forensics advanced, forensic laboratories grew larger and more complex (Fridell, 2007). The world's first forensic laboratory was the creation of Edmond Locard, whose most important contributions to forensics has come to be known as the "exchange principle" (LeMay, 2016). He theorised that criminals leave traces of themselves at crime scenes, and crime scenes or victims leave traces on the criminals. The job of the criminalist, according to Locard was to find and analyse those exchanges. Fittingly, this new-found knowledge was spreading across jurisdictions, including England, and the United States (Steverson, 2008). Locard was only able to achieve this, due to established legal systems where physical evidence and scientific evidence was permitted, and organised law enforcement bodies able to train personnel to follow the principles of criminalistics and adopt forensic traditions. This afforded further credibility to experts and their opinions, as they were testable and backed by scientific principles.

Research shows that throughout most of the nineteenth century the methods used by detectives had not changed dramatically from the old-style practices of relying on human intelligence (i.e., informants and eyewitnesses), common sense, observation, and coercive force (Lane, 1967; Davis, 1991; Emsley, 2017). These tactics also included proactive information gathering aimed at the identification of repeat criminals. Whereas in the past discharged offenders would on occasion be branded (a legal punishment in France until 1832) or mutilated to facilitate future recognition, with the transfer of criminal recordkeeping from the body of the criminal himself to paper records archived by the state (Cole, 2001), the identification of habitual criminals came to hinge on the accumulation and organization of data about them. As early as the eighteenth century, both Fielding in London and sections of the police in France had been busy keeping records on miscreants, a routine that is known to have preoccupied French criminal-turned-criminalist Eugene Vidocq in the next century (Brown, 2006). Supplementing dependence on the retentive ability of individual detectives to memorize the physical features of criminals, different types of registers with written descriptions, usually arranged in alphabetical order, were gradually accumulated.

From about the middle of the nineteenth century onward, efforts intensified to make the storing and retrieval of information about repeat criminals more methodical, even in England and the United States, where sensitivity to privacy was deeply ingrained in the culture. A major driving force for this effort was the entrenchment of the belief in the existence of a distinct criminal class, separate from respectable society and inhabited by resourceful, increasingly mobile specialists in crime whose identification required more powerful techniques (Johnson, 1979; Davis, 1991; Petrow, 1994; Kaluszynski, 2001; Higgs, 2011). The management of knowledge about recidivists was now regarded as of paramount importance not only for identification,

deterrence, and investigative purposes, but also for supervising released prisoners and serving the expanding norm of considering the past record of a defendant when passing sentence and administering punishment (Fosdick, 1969; Hebenton & Thomas, 1993; Cole, 2001; Stanford, 2009).

As friction ridge patterns on fingertips are the most readily visible characteristics and are accessible to relatively simple visual inspection and comparison, they were the first physical aspect of personal identity to be apparent to humanity. The complex patterns found in fingerprints were realised even by primitive man, as evidenced by their incorporation in prehistoric art and rock carvings (Ashbaugh, 1996). Fingerprints for identification were used by the Babylonians and subsequently the Chinese for trade, as evidenced by archaeological remnants of clay tablets and other legal documents carrying the prints of interested parties (Morland, 1950). Marcello Malpighi in the seventeenth century and John Purkinji, in the early nineteenth century remarked on the nature of fingerprints, but it was not until the late nineteenth century that their utility in establishing individual identity and solving crimes was fully appreciated (Morland, 1950; Thorwald, 1964; Moore, 1999).

The credit for this recognition of fingerprints as an apparatus for identification and detection was contested by Scottish physician Henry Faulds, and Sir William Hershel, a British officer employed by the Indian Civil Service. Hershel had utilised prints since the mid-1800s, as an alternative to written signatures for illiterates, and as a means to verify document signatures. He banked on the idea that the indigenous Indian population considered a transfer of body material as a binding contract. Faulds, however, specifically appreciated the potential of fingerprints left at a crime to identify perpetrators. In one of the first recorded cases of fingerprinting to solve a crime, Faulds eliminated an innocent suspect before implicating the wrongdoer in a Tokyo burglary (Thorwald, 1964).

In 1880, Faulds published the first paper outlining the nature and uses of fingerprints in the journal *Nature*. Sir Francis Galton, first cousin to Charles Darwin, consolidated the available information on the subject and published the first paper dealing with the statistics and significance of fingerprints (Galton, 1888). Galton also published the first comprehensive guide on the nature of fingerprints and their possible uses in solving crimes (Galton, 1892). In the book, he afforded Herschel, rather than Faulds, credit for the initial publication in *Nature* (Cole, 1999).

Fingerprint identification was introduced at Scotland Yard in 1901 by Edward Henry, after taking up the role of assistant commissioner in charge of the detective branch of the Metropolitan Police. Together with Aziz ul Haq, his assistant in India, Henry perfected the system by designing an effective means of classifying fingerprint patterns. Fingerprinting was

soon hailed by many as the most effective tool in the hands of the police. Not only was this identification technique cheaper, easier, and quicker to learn and use than Bertillonage, it was also better in its accuracy, required less labour, and constituted a massive jump forward in identifying criminals who had left their imprint at the crime scene. It became known known as the means that allowed investigators to link criminals to a crime and obtain indisputable forensic evidence for securing or refuting a defendant's guilt (Cole 2001).

While until the early twentieth century it was widely accepted that Scotland Yard—the creme de la creme of British detection—lagged behind continental powers in its utilization of scientific aids, modern fingerprinting established its popular image as keeping abreast of scientific developments and the reputation of the British as particularly good at detection. The already-discussed legal, cultural and societal factors were undoubtedly drivers for this. However, there could be another structural reason for this stunting of scientific progress.

For centuries, scientific principles were not applied to legal disputes in Western societies. There was a dangerous trend of branding as heretics, anyone attempting to explain the natural world in any other means than theology (Langford, 1992). The historical reliance on witness testimony grew exponentially, well into of the nineteenth century. One driver for this phenomenon was the prevalence and dominance of theology. Witnesses were expected to testify the truth because having sworn on the Holy book, the punishment for lying under oath was thought to be much greater by God, than by any punishment handed down by man (Schramm, 2000).

In fact, there was great resistance to the progression of science by religious institutions throughout the past millennia (Draper, 1875). Science as we know it today may not have been recognised or acknowledged, however, scientific principles governed death investigations beyond Europe. A notable practitioner of these practices was the Chinese investigator Sung Tz'u.

This formalisation process of scientific inquiry for the investigation and adjudication of crimes can be traced to an ancient Chinese manual describing methods of death investigation titled 'The Washing Away of Wrongs'. It described one of the first uses of forensic science in ascertaining guilt. Copies written in 1247 AD have been recovered, but the book had existed much earlier than that. The author is listed as Sung Tz'u and titled 'Hsi Yüan Lu'. The book was used as late as the 20th century and included information on strangulation, drowning, wound characteristics, poisons, and even instructions on forensic dentistry, to assist modern criminal investigations. Characteristic changes in the post-mortem interval (PMI) were discussed to provide a means of estimating how long a person had been dead.

Sung Tz'u's work was notable because it was a manual expressly for death investigators. A death investigator was charged with providing information that would be used during an inquest, which in China, was an investigation of a questioned death held at the behest of government officials. In English law, the procedure became known as a coroner's inquest, and such investigations were common throughout recorded history — except in China, there was a scientific basis for them. Sung Tz'u is therefore, the earliest known record of death investigation in the forensic tradition.

Sung Tz'u composed the volume hoping that it would serve as a guide to the officials across China faced with crime and criminality. The book had an immense influence on the administration of Chinese justice and continues to be a fascinating source of guidance even today. For centuries, the book was modernised with updated forensic information, outdated information was deleted, and for almost seven centuries guided investigators in their examinations.

Sung's book provides the clearest picture of traditional Chinese detective processes. There is throughout an emphasis on speed. The object was in part to reduce the difficulties of detection which resulted when bodies were too far decomposed to permit examination. Sung's success and the visionary actions of the Chinese criminal justice system as early as the thirteenth century demonstrate that there may have systemic hurdles to the advancement of forensic principles in Europe. The nationalisation of scientific knowledge for criminal investigative purposes at the time, and after Sung Tz'u illustrates the lack of resistance to scientific endeavours as opposed to Europe, where resistance was prominent due to the role of Christianity.

Despite the glorification of Western knowledge, and its role in shaping modern criminal investigations, the evidence of Chinese ingenuity and legal practice from the thirteenth century, and perhaps the first manual of crime scene investigation lends inquiry as to why Hans Gross' Handbuch für Untersuchungsrichter (1893) is still considered the first handbook on crime scene work. Even if historically, and on some principal, this were accepted, it came almost six hundred years after Sung Tz'u's book. The operative question is, what could have accounted for this delay.

China, once it was opened to foreign ideas by the Jesuit missionaries in 1583, provided previously unthinkable opportunities for European scientific exploration (Basalla, 1967). The natural history studies of the first missionaries were expanded, as scores of European thinkers travelled to China from the seventeenth century. Botany caught the attention of many Europeans. It resulted in thousands of pages being written about European botanical discoveries in China.

However, Sung's manual or the robust evidence handling system of China did not make its way to European legal traditions. The explanation as to why, could again be pointed towards the legal norms, and lack of organisational law enforcement for the scientific knowledge in the manual to be of any practical use to Western societies.

The reality was that there was very little scope for scientific thinking to develop during the Middle Ages. The formulation of the doctrine of papal infallibility and the Roman Catholic Church's pronouncement that public institutions teaching science were not exempt from its authority were a phase in the history of the expansive force of the human intellect in conflict not with religion generally, but with that compression inflicted by Catholicism (Draper, 1875).

At the time, individuals who identified as philosophers and those described as scientists, took it upon themselves to be reflective of the methods used in science. From the seventeenth century to the nineteenth century, scientific beliefs supplanted religious convictions, taking heed to elucidate on the nature and scope of the authority which allowed them to do so. The times reflected a propensity to question, implicitly or explicitly, the authority of religious claims. The validity of scientific claims was also a matter of debate. Galileo (1610, 1632) challenged the authority of the Church with respect to matters which, in his view, lay outside its scope. He drew conclusions about the structure of the heavenly world from evidence concerning the apparent world — the only world legitimately available to scientific investigation.

Darwin (1859, 1888) defied the power of the Church by claiming that with his theory of evolution, he could explain the appearance, structure and behaviour of living creatures which was previously accepted to point to the work of a divine creator. Critics were quick to argue that if the only reason for believing the theory of evolution was its ability to account for such facts, then there could be no objection to other theories either, including the theory postulating a divine creator. For either proposition to be established as the likelier prospect, arguments would be required to justify the reasons for society to place trust in it.

In modern times, 'science' has become a greater enquiry into how the greater Cosmos works, from the Big Bang to global warming: from subatomic particles to clusters of galaxies. Science and technology have grown accustomed to solving problems and meeting the needs of society. Powerful miniaturised computers, placing humans on the Moon and developing worldwide systems of communications are examples of the unison between science and technology. However, science has not been so successful in creating crime-free utopias of contented people or abolishing the eternal problem of religious divides and/or race relations.

Until the beginning of the twentieth century, scientific knowledge was limited in its scope and as a result, its significance in any practical capacity. Industrialisation had taken effect in parts of western Europe, but it was the management of the process rather than the technology and

science it utilised that raised moral and social concerns. Scientific discoveries provided entertainment and intrigue for the masses but did not represent anything more than intellectual pursuits with any utility.

However, science and technology (applied science, empiricism) were fundamentally and necessarily interrelated during the Industrial Revolution (Musson & Robinson, 1969). The scientific revolution of the sixteenth and seventeenth centuries resulted in the establishment of the principles and laws of physics (heat, work, energy, thermodynamics, motion) and chemistry (elements, reactions, thermochemistry), which propelled science as being not just a flight of fancy for the elite, but something that could be beneficial for the masses in the form of technology. The Industrial Revolution represented practical application of science to increase agricultural and industrial production, create new materials, processes and manufacturing methods, improve health, and generate new sources of power.

The actions of government bodies played a key role in this science-and-technology-driven industrialization (Clow & Clow, 1952). The passing of Acts affording privileges to investors in industry (capitalists), setting up awards for inventions, granting patents passed Acts of Enclosure, and even lowering interest rates for cheap capital to be available for investment. This coincided governmental steps to professionalise law enforcement and assisting to uphold a robust judiciary. All of these factors contributed in conjunction to allow for scientific innovations in investigative endeavours — leading to the formalisation of forensic science, and by extension, crime scene investigation.

The Technology/Society Link

'Technological determinism' refers to a pervasive, nevertheless disputed theory concerning the link between technology and society. Although the term has had a range of meanings, two connected assertions are central to discussions: (1) technology development takes place autonomously, determined by an internal logic independent of social influence; and (2) technological shift determines social change in a prescribed manner (Staudenmaier, 1985; Misa, 1988; Bimber, 1994).

The claims examine how and why technology develops and the link between technological and social change. Arguments against the primary claim have become a staple of analysis within the sociological history of technology in recent times. The second claim has been debated with regard to Karl Marx's theory of history since the early twentieth century. Generally, philosophical analyses concerning technology maintain that the latter could be a principal cause, however not the only driver of social change.

It is necessary to differentiate between assertions that autonomous technology is the main cause of social change, and use of the term technological determinism. In the U.S., the Enlightenment doctrine, which prescribed that enhancements within the mechanic and industrial arts drove social progress, was steadily replaced over the course of the nineteenth and early twentieth centuries by an additional technocratic construct of progress, which sought to foster enhancements in technical and economic efficiency as ends themselves, rather than simply means for reaching desired social ends. Technology is an autonomous social force, one which holds great capacity to further scientific objectivity and systematic knowledge (Marx, 1994, 1997; Oldenziel, 1999).

The recent term 'technological determinism' stemmed from conversations about Marx's theory of history, by social scientists (Bober, 1927; MacKenzie, 1984; Miller, 1984). It was also a subject of research by scholars of science, technology and society (Cohen, 1978; Staudenmaier, 1985). Keeping with increased focus on social constructivism since the 1970s, technological determinism established itself as a concept to analyse and often criticise theories of technology and society.

There are several forms that technological determinism can take, including normative, nomological, and unintended-consequence (Bimber, 1994). Under normative accounts, the claim is that society is allowing political and ethical norms to be overridden by the objectives of technologists, such as efficiency and productivity. Nomological thinking on the subject dictates that technology develops autonomously in accordance with an internal logic, forcing a prescribed societal change (Heilbroner, 1967). Unintended-consequence states that technology produces unexpected and unpredictable social changes. Other forms of technological determinism include such models as impact-imprint (Fischer, 1992), which argues that the capability of technology (the ability of the internet to connect billions of people to interact with each other) leads to predictable impact (i.e. new forms of communication patterns).

These conceptualisations of technological determinism are useful to contextualise the social construction of technology, including forensic technologies and the systems that drive crime scene practice. Sociologists and historians have, since the 1980s argued that technological development was the consequence of negotiated outcomes between social groups (investors, engineers, managers, salespeople, and users) (Pinch & Bijker, 1987; Staudenmaier, 1985). However, after examining the history of crime scene work and the technologies that enable its successful execution, it can be put forward that technological change can be driven by social, political, cultural and legal developments and that oftentimes, technology can only progress and reach its potential if negotiations between these various factors coincide towards a common goal — in the case of crime scene practice, it was the common objective of upholding justice

and legitimacy of the executive and judicial branches of government. The system stands on these legs, and if negotiations between any of these fail, or is strained, the consequences could be unpredictable and precarious for the discipline.

While nomological definitions of technological change have been argued to make most sense in this case, all three conceptualisations can be applied to crime scene investigation. Technologies once thought to be in the realm of forensic science has made it into mainstream consumer use, such as fingerprint and biometric systems in cellphones and the advent of ancestry websites comparing and matching DNA samples. These could be described as unintended, or unexpected consequences of the proliferation of such technologies in police work, but their development owes greatly to forensic science and crime scene practice. Arguments can however be put forth that without these technologies developing independently, and autonomously, criminal justice would not have been able to adopt them and grow. There is therefore, a strong basis to argue that a symbiosis between technological progress and societal change exists.

CONCLUSION

The history of legal traditions, law enforcement and scientific enlightenment demonstrates several key themes which can be used to analyse the present state of disciplines such as crime scene investigation. Evidence has undergone several evolutionary stages since witness testimony and confessions extracted through coercion and force were a mainstay. Developing legal accommodation for other forms of evidence, a culture of record-keeping and document preservation, the role of the media in proliferating new investigative techniques and potential of expert evidence were a key driver for scientific enterprises to thrive in the nineteenth century. This coincided with the continuing scientific revolution dating back to the seventeenth century. Galileo and Darwin had opened the doors for critical thinking, beyond theology for scientific endeavours to be used for means other than just appreciate the majesty of an all-powerful creator. The law, public support, and the science at hand, all that remained for the adoption of forensic science methodologies to criminal investigations, were the investigators themselves. The only way crime scene work, or forensic science could maintain reliability, credibility and authenticity was to be taken up by trained individuals who could be presented in court as unbiased experts and operate under the authority of the state. Security, funds, equipment, and infrastructural support were some of the other advantages for crime scene investigation to develop in the public sphere.

The model is followed even today, with forensic science laboratory work being outsourced regularly by law enforcement in the UK, and other jurisdictions, but crime scene investigation has largely remained a public good. The discipline may have developed sooner, had knowledge exchange from China, and in particular, death investigator Sung T'zu's investigative manual

reached Europe before the nineteenth century. This is indicative of the benefits of globalisation and the knowledge transfer apparatus of the modern world. It has made possible continuing professional development for forensic science practitioners and made techniques and scientific breakthroughs more accessible and adoptable for law enforcement all over the world.

Crime scene investigators often cite the scientific method as being essential to their work (Shaler, 2011), and the discipline does owe its inception in some part, to the introduction of scientific thinking. However, in recent times, crime scene investigation and forensic science itself has faced questions about its scientific validity. With the identification of key components in the developmental history of forensic science, and by extension crime scene work, the chapters that follow, will examine (i) the role and responsibilities of crime scene practitioners; (ii) the resources that are afforded to scene examination, and forensic science; (iii) the state of organisational record-keeping at law enforcement bodies; (iv) new science and how they could explain the complexities of crime scene investigation; and, (v) how public confidence can be maintained, and justice can be assured through robust mechanisms of quality control.

Crime scene investigation has come a long way, since the earliest instances of physical evidence handling in Athens, and Rome. This work will work towards answering, in the ensuing chapters, how far it may still have to go to reach its full potential.

In the next chapter, the crime scene — the place where scene practice is understood to take place, will be examined from a conceptual perspective to determine the complexities and boundaries of forensic spaces, and whether it can shed light on the nuances of scene work. Examination of crime scene practice would need to start at the scene which is the conceptual space in which practitioners engage in their occupational responsibilities. Conceptualisation of the scene would assist in world-building, or the conceptual boundaries of scene work, by demarcating spaces around scene practitioners and the various interactions and processes that define the discipline. As such, the next chapter will examine the crime scene through analytical and conceptual frameworks with a view to making sense of the apparent randomness of scenes and the significance of the tasks at hand for scene staff even after the most simple seeming of scenes.

CHAPTER THREE

Crime scenes, as opposed to scene investigation/examination are rarely defined in any significant detail. Texts sporadically reference scenes as merely the spaces where crimes occur, or in more general terms, those spaces which are declared to be such, by first responders or crime scene practitioners (Weston, 2010; Maloney & Housman, 2014). It has been referred to as the location of the crime (Fish et al. 2013), an area that is never static (Evans, 2009), that which contains evidence (Lewis, 2004), and an ever-changing ever-evolving matrix of circumstances (Miranda, 2015). Scene investigation texts have also been found to completely circumvent any comment on the definition or conceptual boundaries of the scene itself (Pepper, 2010; Ramirez & Parish-Fisher, 2011; Millen, 2008). The same can be said of more specialised literature such as works on scene photography (Robinson, 2016) and ballistics (Kling, 2008). There are intermittent acknowledgments that scenes can vary in size, scope and complexity (Wallace Jr et al. 2016), but most commonly no explanation or definition is offered even by principal stakeholder guidance literature, such as from regulatory bodies (NFSTC, 2013). While recognition of this lack of focus on crime scene conceptualisation is limited, appreciation of the importance and significance of such conceptualisation is becoming apparent in recent times (Julian et al. 2012; Miranda, 2015).

Commentators have argued that crime scene practice has not received the attention and investment it deserves due to poor understanding of the discipline, despite its importance to forensic science and criminal investigations (Wallace Jr et al. 2016). Home Office, and the Forensic Science Regulator publications on forensic science in the UK (discussed in detail in Chapter Six), and the National Academy of Sciences (2009a) and PCAST (2016) reports in the U.S. accentuate claims that crime scene practice only make up for a minute fraction of forensic science-related policy literature. Research has supported the idea that crime scene work is a misunderstood discipline and that misconceptions hinder its progress (Wilson-Kovacs, 2014; Wyatt, 2014). It is therefore imperative that the scene be defined first, rather than those operating within those conceptual and physical spaces as it is the former that shapes investigative approaches.

One of the common themes of this thesis is the continued focus on the complexity of crime scenes as conceptual and physical spaces, scene work within them, and the contribution that crime scene practitioners make to the overall criminal investigative process, which make them indispensable to the overarching system of justice in modern societies. Chapter Two traced the development of crime scene investigation, starting from the time when the value of crime scene analysis, and more broadly the importance of physical evidence, was largely not understood. In recent times, it is almost unimaginable that police forces would willingly shun forensic science,

and by extension crime scene investigation for more archaic methods of law enforcement, such as intimidation, or physical violence to coerce a confession.

The abstract concepts of time and its relationship to space is a thematic underpinning that both the hard sciences and scene investigation share. While physicists attempt to reverse engineer time to understand the nature of the universe, and how it all began, crime scene investigators use different techniques, still trying to reverse time, in order to theoretically return to a point before, during or immediately after the commission of a crime, or any other event that their investigation dictates. The former is however held in higher esteem due to the adoption of the scientific method, and largely operating within conceptual frameworks, while the latter is seen to operate on instinct in a non-systematic manner. It is therefore imperative to examine whether conceptual frameworks can be used to rationalise the work done by scene examiners, that can inform policy, standard operating procedures, quality control, and elevate the practice of scene examination to its deserved place in the criminal justice sphere.

Conceptual frameworks in crime scene investigation research are rare, but not unheard-of (Miranda, 2015; Rossy & Ribaux, 2014; Inman & Rudin, 2000; Buss & Shackelford, 1997). There have been attempts to conceptualise the communication model of forensic science information (Howes, 2015), the rationalisation of evidence using argumentative story-based theory (Bex, 2011), the evaluation of associative physical evidence in legal contexts (Gaudette, 1986), the psychological study of coherence and management of evidential artefacts (Twining, 2006), the fragile nature of evidence in an ‘evidence matrix’ (Miranda, 2015: 59), and the management of crime scene tasks (Julian et al. 2012).

Crime scene investigation in modern times operates largely on the basis of a paradigm known as Locard’s Exchange Principle. Paradigm is another name given to the principles within which knowledge is produced. It refers to the basic concepts and experimental practices of a scientific discipline (Kuhn, 2012). Edmond Locard's exchange principle states that every contact leaves a trace, meaning it is impossible for a criminal to act to be committed without leaving traces of its presence at the scene. Traces of the perpetrator(s) such as fingerprints, semen, blood, hair, skin, fibres, footprint or impression evidence could potentially transfer to the scene, or other objects and entities at the scene. The paradigm assists scene examiners to rationalise scenes and search for evidence. As cross-contamination is a real possibility at crime scenes, examiners consider and take preventative measures against it, keeping in mind Locard’s principle.

A paradigm is therefore established, in part, by the rules which are generally acknowledged as necessary to follow in order to produce ‘good’ knowledge (Jackson & Carter, 2007). More importantly, paradigms contain shared beliefs and suppositions of knowledge producers about the definitions and scope of knowledge, and, which shared beliefs and assumptions are

institutionalised through support structures, such as universities, and through training (Rouse, 2003). Though a paradigm constitutes a model for solving problems, it does not provide a conceptual basis to contextualise itself within a larger system.

There are many principles which are misrepresented as crime scene paradigms, where they actually relate to laboratory testing, analysis and results generation. One of these is the concept of individualization (Kirk, 1940). If an item can be classified into a group with only one member (itself), it is said to have been individualized. Once an individualized item has been associated with one, and only one, source, it can be termed as unique. The characteristics that allow for individualization depend, largely on raw materials, manufacturing methods, and history of use. In that context, individualization is the logical extension of classification, where concept rests on two assumptions (Houck et al. 2017): (1) all things are unique in space and time; (2) the properties by which a thing is classified is constant over time.

This supposition of uniqueness of space is essentially nonprovable, however. The population size of everything that might be classified as evidence is too vast for any demonstratable computation (Saks & Koehler, 2008). Forensic science is somewhat forced to make interpretive statements based on statistical methods to deal with such uncertainties. The variance between the controlled laboratory and the real, more uncertain world is central to the fundamentals of forensic science (Houck et al. 2017). However, calculation of certainties in probability models may not be the appropriate method to conceptualise the real-world uncertainty associated with crime scene investigation.

The reason behind this can be found in the nature of the work undertaken by crime scene personnel, and their laboratory-based forensic scientist counterparts. Forensic scientists have been said to define their roles to maintain the same objectivity that characterizes other scientific work. As crime scene investigators are rarely considered by commentators to be scientists (Tinkey, 2019) or their work scientific (Millen, 2000), examination of this aspect is complicated. Conceptual frameworks may assist with this difficulty by framing crime scene work in terms that can be easily translatable to other scientific endeavours.

Conceptual frameworks can be viewed as visual representations of a study's organization or major theoretical precepts, where such a representation is usually included within the literature review, generally as a stand-alone figure (Ravitch & Riggan, 2016). A second perspective can be that conceptual and theoretical frameworks are essentially the same. As with theoretical frameworks, the meaning of conceptual frameworks in this sense depends on the meaning of theory. Problems can arise if researchers are vague about such definitions, as conceptual/theoretical frameworks in this sense can refer to either existing or researcher-formulated theories.

A third interpretation can see conceptual framework as a way of linking all of the elements of the research process: researcher characteristics, interest and positionality, and the literature review, theory and methods for the research. It is this view that was endorsed by Ravitch & Riggan (2016). Conceptual frameworks were argued to be related to other critical components of the research process, such as theory and literature review.

The purpose of a conceptual framework is to learn from the experience and expertise of others as one develops one's own knowledge and perspective (Maxwell, 2012). A conceptual framework allows researchers to make reasoned, defensible choices about how research topics or themes heretofore underexplored, are explored. Existing research questions can be examined in new contexts, or established topics or questions using different theoretical or epistemological frames re-examined (Bordage, 2009). Conceptual frameworks match particular sets of research questions with those decisions, and in turn align the researcher's analytic tools and methods with those questions. They also afford a critical lens through which researchers may view their work and roles in carrying out the work.

Conceptual frameworks guide the ways in which researchers formulate methods concerning collection, analysis, description, and interpretation of data (Sinclair, 2007). It has been argued to be a core, driving component of the empirical research cycle. Development of guiding research questions, the literature review, the structure of the thesis, significance of the research and its connection to broader discourse communities, are all grounded in conceptual frameworks. Thus, frameworks facilitate the conceptualization and articulation of the reasoning or rationale for often difficult to research subjects, supporting intellectual and methodological rigour, assisting with the determination of the methodology and informing the research design in a recursive manner (Egan, 2002).

Given these benefits, it is surprising that conceptual frameworks have not been more widely used in crime scene research. In forensic contexts, crime scene examination can be said to be commentaries on application of scientific principles and establishing their validity in the real world. For instance, the analysis and successful interpretation and documentation of a high-velocity blood spatter can stand as a point of reference for the existence of the principles of motion, gravity, and fluid dynamics among others. There have been calls to consider each crime scene examination as a separate research project (Shaler, 2011). One shared characteristic between research endeavours and scene work is hypothesis-building based on evidence, and empirical data collection and analysis.

Competent crime scene work is argued to be as cerebral an exercise as any scientific endeavour in the forensic sciences (Roux et al. 2015). Commentators maintain that scene work is as

comprehensive, tedious, and difficult as any scientific exercise — it is an amalgamation of experience, training, and education (Daeid, 2010).

The real complexity of scene work is less the mechanical action of picking up an object, bagging and tagging it, or the manual collection of traces or fingerprints from a surface, and more the various stages of hypotheses building, testing, and proving/disproving, which leads to evidence discovery (Shaler, 2011). Detractors can attempt to dismiss this complexity by arguing that human beings, in general, constantly form provisional hypotheses during their lives and it is a mere extension of that practice in criminal investigative endeavours (Baber, 2017). It is generally agreed that without provisional hypotheses, one cannot function in life; and that every decision would need starting from neutral, with all possibilities equally probable (Inman & Rudin, 2000). Thus, the requirement arises to remove preconception, and to identify hypotheses and the suppositions from which they stem (Dror, 2013). This information can be utilised to inform and drive actions and can alter hypotheses when new information presents itself. However, when confronted with the remnants of a criminal action, the objective of the police is to solve the case and charge the perpetrator(s) in the most effective and swift manner. The dexterity involved in piecing together past events through its remnants is a specialised skill (Reppetto, 1978), one which is attributed readily to detectives and forensic scientists (Edmond & Roque, 2014), but with marked reluctance when it comes to crime scene personnel.

Practitioners at the crime scene must determine what crime has been committed, what the legal elements are, and what evidence can be found. All three require specialised skills and/or knowledge. Immediately following recognition of the crime, the investigator will learn information that is expected to lead to a preliminary hypothesis (Ribaux et al. 2010a; 2010b). The challenge presented to an investigator, in this case, is the determination of what evidence exists, and/or could exist.

The investigator must take into account suppositions on what evidence should exist given that the perceived crime occurred (Berg & Horgan, 1998). These complementary concepts are based on the expectation of the investigator, either based on previous experience or on-the-spot reasoning. To hold an expectation, the requirement is to have information about the crime itself. The anticipation stems from rationalising what physical manifestations can be expected due to the hypothesised event/action. While a provisional hypothesis is often required to work a crime scene and instigate the search for evidential artefacts, the practitioner must also be open to updating his/her initial hypothesis if additional information surfaces. This continues until the investigator is convinced that no additional information can change the latest hypothesis about what happened, or the possible perpetrators to the crime.

It is therefore vitally important that a sound, logical conceptual framework underpins and drives the crime scene investigative process. As with Locard's paradigm, there are several principles that underline and guide scene work. Commentators often refer to the importance of understanding the basic concepts behind crime scene techniques, alluding to concepts like striations, which are scratch marks caused by irregularities or lack of microfine smoothness, such as those found on fingerprints, bullets, cartridges, casings, or tool marks (Lewis, 2004). Understanding of chemistry has been said to provide the details to identify and recover items like paint, hair, grease, and glass, where the chemical composition (qualitative and quantitative) play a crucial part. For fragmental evidence, morphology can be the aspect that aids in its documentation and collection. Blood spatter documentation and pattern analysis involves a combination of physics principles (such as motion, pressure, gravity) and mathematical equations, as does bullet trajectories and shell casing location.

A comprehensive, effective, and efficient crime scene investigative endeavour is, as such, the successful combination of several unique, and often varied set of skills (White, 2010). It is an intellectual enterprise that requires scene experience (Ribaux et al. 2010b), attention to detail (Douglas et al. 1986), a sceptical perspective (Lee & Pagliaro, 2013), developed powers of observation (Jamieson, 2004), in-depth knowledge of criminalistics (Saferstein, 2017), and the ability to apply deductive and inductive reasoning as embraced in the scientific method (Shaler, 2011). Not everyone, including some forensic scientists, possess the intellect, the experience, the credentials, or the ability to investigate a crime scene effectively. Although the steps listed in the scientific method seem straightforward, applying them correctly during a scene investigation is not easily done. Forensic scientists often retain only a singular skillset or expertise, for example, forensic DNA analytical skills, and may rarely, if ever, venture outside of the laboratory. They may also not have the requisite credentials to be a competent crime scene investigator — a person often relegated to evidence collection, packaging, and preservation, declaring it an unthinking and unintelligent task.

In scientific endeavours, tasks are divided between important (though necessary) administrative functions and the application and interpretation of the scientific data. Under proper scientific supervision, scene investigators are trained to apply the science at the scene, for example, developing fingerprints, recognizing bloodstain patterns, chemically enhancing footwear prints, lifting impression prints, and so on. This is the manner in which most scenes are investigated in modern times.

Whether crime scene investigation is science, and scene examiners scientists remains largely unexamined. however. The nature of scene work has been argued to be much more than merely dusting for prints or bagging evidence (Sutton et al. 2016). Commentators have also pointed out

that specific tasks, such as blood evidence can add complexity to the scene investigative task (Gardner & Krouscup, 2016). 'Crime scene investigator' and 'examiner' have been used as interchangeable terms for decades, but Horswell (2004) drew a distinction between the two by stating that the examiner merely collects the evidence, while the investigator interprets the collected evidence as well. Under this classification, investigation was argued to be more complex than examination. Such distinctions, while declaratively definitive, do not shed much light into the actual complexities of the work (Julian et al. 2012). They have also been largely ignored, as the terms examiner, analyst, and investigator are used as synonyms in jurisdictions around the world (Fish & Fish, 2003).

Professional issues in crime scene practice, such as role strain (Huey, 2010), and perceptions within police forces (Wyatt, 2014) is documented, but leave the inner-workings of the work to remain relatively black boxed. Role strain has been argued to be an expansion of role theory which refers to the struggles individual actors experience when trying to fulfil manifold obligations within their role. The actor's challenge is to make the role system manageable, through allocation of effort and skills so as to minimise role strain to an endurable amount in order to facilitate the accomplishment of various institutional activities (Goode, 1960).

There is also uncertainty of whether crime scene practitioners are even professionals for such professional issues to be attributable to them. The supposition that crime scene investigation is scientific is contentious (Fraser, 2000) and thus unhelpful on the face of it, in this query. Opinion is divided on whether crime scene work is a specialised skill occupation, or whether it is just one of routinised manual labour, where investigative cognition plays a minimal role. There is insufficient knowledge about the conceptual underpinnings of the various aspects of scene work. None more so than the spaces in which examiners operate, and the contribution of examiners within these spaces, and the results they produce.

Towards the Conceptualisation of Crime Scenes

Conceptually, crime scene investigation has yet to be definitively defined. There is widespread discrepancy in the classification of many crucial aspects of crime scene practice, including the nature of the work (both as a group, and as individuals), the contribution of crime scene work to the overall criminal investigative process, and the distinction between crime scene practitioners and others in criminal investigations.

Such conceptual analysis can be challenging if the sandbox in which the multiple interacting variables culminate to form the final material representation of the aftermath of a criminal act — the crime scene, is not well defined. Unlike traditional interpretations, this chapter aims to illustrate how systems analysis of the crime scene as an area of any dimension, treating all

interactions human/nonhuman alike as input variables, including first-responders and even scene examiners, within it, yields the final output.

Traditionally, the site or location where a crime has been committed is given the designation of a ‘crime scene’. It can be any open or closed space (Baryamureeda & Tushable, 2004). It can relate to any area, demarcated, or otherwise, where the commission of a crime is suspected (Lee et al. 2001). The definition often facilitates the preparation of a scene examiner or investigator to locate, identify, recover and store physical evidence. However, this simple designation does not offer any assistance to the crime scene practitioner in terms of the forms of evidence, or the challenges in processing the scene.

Crime scenes can comprise of a combination of macro and microscopic classifications of evidence, and can contain a variety of evidence types, depending on the activities which may have taken place at the scene. Scenes can be indoors, outdoors and in a multitude of settings (Miller, 2002). For crime scene reconstruction, these distinctions are useful, but they are not assistive in terms of physical evidence anticipation, as each scene is different and brings with it its unique challenges (Roland, 2006).

The definitions can be used as a means of anticipating the equipment and resources needed for a particular scene. There are invariably some crime scenes which commentators describe as being more challenging than others, and as such, preparation and planning is key. The process is rarely the unthinking, non-sequential, haphazard activity described by commentators to explain crime scene work.

Crime scene investigation is a complicated endeavour. Mapping the methods and methodologies associated with crime scene work is a challenging area of research (Crispino, 2008; Baber, 2017). Despite numerous grounded approaches to determining the nuances of everyday work for crime scene practitioners, stakeholders are no closer to understanding the unique challenges facing those in the field.

There have been attempts to define conceptually what forensic science needs to achieve, with the premise that it will enable the identification and development of the approaches that tie in different domains effectively to provide robust, transparent, accurate, problem solving forensic science (Morgan, 2017). Commentators recognise the need to view crime scene work conceptually due to its various roles in the criminal justice process, such as evidence rationalisation, interpretation and presentation (Gardner, 2011), as well as the answer-seeking function to complex problems (Fisher & Fisher, 2003). Crime scene management has also been conceptualised as a fundamental component of forensic science (Julian et al. 2012; Crispino, 2008). This is a departure from previous notions where the crime scene was not part of conceptualisation of forensic science. In the past, activities at the crime scene were seen to be

'police work' and the processing and managing of the scene as a technical discipline (Crispino, 2008; Millen, 2000).

Julian et al. (2012) identified three critical issues at crime scenes, in their attempt to conceptualise scene management as an essential component of forensic science: (1) recognition of the crime scene and the role of first responders; (2) identification of appropriate expertise and the problem of 'extended' expertise; (3) effective control of complex crime scenes. However, the study, as with the predominant literature on the subject, averted from conceptualising the crime scene itself, and focused solely on the practitioners and the work. The characterisation of a separate category of crime scenes as being complex, failed to take into account the inherent complexity of all crime scenes.

Miranda (2015) argued for a conceptual framework titled 'Evidence Matrix' where two factors related to the documentation and recovery of physical evidence were identified as the fragility of the evidence and the destructive nature of the processes/procedures used to recover it. Fragility was defined in two ways: (1) the physical nature of a given item and/or (2) the relationship between an evidence item and its surroundings. Destructive was described as: (1) any process/ procedure that has the potential to change the relationship of the evidence to its surroundings (including other evidence) and (2) any process/procedure that physically changes the evidence in any manner from its original state as found at the scene. Understanding the relationship between these two factors was said to help maximize the recovery of the evidence at a given scene.

Classification of crime scenes in terms of mere surroundings does not however adequately address gaps in the knowledge about crime scenes beyond existing narratives. Arbitrary and disjointed classifications and descriptions of evidence fragility and scene degradation fail to address any systematic examination of crime scenes as something other than an area where evidence can be found. In fact, it fails to acknowledge the benefits in analysing crime scenes as a system with its own set of variables.

Scenes as an Assemblage of Interacting Variables

Crime scenes are constantly changing mini-ecosystems, in that they contain constantly changing (Miller, 2002), interconnected objects and organisms interacting with the environment that they occupy (Chisum & Turvey, 2011). They are privy to movement of objects (Hazelwood & Napier, 2004; Ludwig et al. 2012), the creation and destruction of organic and inorganic matter (Bevel & Gardner, 2008), and is subject to active forces, even in static conditions with no discernible motion (Gardner, 2011). Theoretically, crime scenes can be said to share several qualities, with systems referred in science as dynamic systems (Van Geert, 1994).

In forensic contexts, such systems analysis can lend a range of real-world benefits to commentators and practitioners by providing information for interpretation of forensic events and settings (Boyd & Boyd, 2011). These can include (1) temporal and spatial contexts to explain the events leading up to the discovery of a crime scene; (2) the definition and identification of the scope of human and nonhuman intervention, through the various stages of transformation of the scene, from the commission of the offence, to the discovery of the scene, up to the processing of it by the scene practitioners; (3) understanding the implications of evidential artefacts in the context of degradation to estimate time of offence, number of perpetrators/actors, and the likely events leading up to the acts or omissions subsequently discovered by forensic practitioners; (4) adding theoretical value and meaning to case studies and unique problem scenarios assisting practitioners and commentators to make sense of new data.

Choice is a vital component in forensic contexts, particularly crime scene investigation. Practitioners are tasked with making crucial decisions at every junction of scene investigation, from the moment they walk into a scene, setting the common approach path(s), to the services that they dust for fingerprints, or swab for biological material. The logical foundation for such decision-making is often lost on commentators and other criminal justice actors. Reclassifying crime scenes as systems with dynamic properties rationalises the work done by examiners as beyond 'bagging and tagging' (Fouche & Meyer, 2012) and more akin to systems analysis, where stages of analysis, planning and implementation result in the final output.

Crime Scenes as Dynamic Systems

Crime scenes share several characteristics with dynamic systems, where aggravation and acceleration can be seen in the corrosion of matter. Dynamic corrosion of matter is a test which has been used to determine the changing conditions on the corrosion behaviour of materials. The output of dynamic systems is dependent on past and future values. At a crime scene, this could involve a metallic pipe covered in blood left in an open space (a murder weapon), where it is subjected to sun, rain, sleet and snow. As a result of exposure to such external forces, the corrosion rate would be much higher than it would be, had it been stored in a climate-controlled enclosure where the conditions are more static.

Dynamic systems have been found to be difficult to model, if the evolution of dynamic behaviour is not understood adequately. Long-term corrosion rates for different materials in both static and dynamic states can be performed to document corrosion processes to map out the corrosion over long periods. However, unlike dynamical systems, a concept often confused with dynamic systems, the results are often not capable of being calculated by mathematical certainty due to variables which are unknowable.

Crime scenes represent an exceptional dilemma firstly as a dynamic system, where shifting properties often in unpredictable ways make it difficult to reach conclusions on the sum, based on the changes of the parts. And, secondly because of its often-random properties in each instance of a physical space (with unique characteristics) being denoted as a crime scene, they are unsuitable for analysis as a mathematically provable dynamical system.

Scenes as Non-Linear Dynamic Systems

None of the variables in a crime scene system can be controlled, and due to this, they cannot be studied with a linear Newtonian model of scientific testing. Crime scenes can therefore be argued to be nonlinear with properties that resemble complex systems. A system is often stated to be nonlinear when superposition principles do not apply to it. The idea of the superposition is often described by physicists as a fundamental means of defining reality and the way it is perceived.

The description of the quantum world in this manner is encapsulated in the well-established double slit experiment (Zeilinger, 1999). A stream of photons or electrons or molecules travels from some point to a detector screen via a pair of slits. The particles arrive at the screen, distributed like the interference pattern one would expect from a simple wave. Quantum mechanics very successfully predicts this result by describing each particle's journey as a superposition of all possible trajectories.

In simpler terms, the particle simultaneously takes all possible paths, meaning it passes through both slits. It cycles through all possible histories between launch and landing. These multiple histories interact with each other to determine the most likely final destination when a measurement is made. In a way, different possible superposed histories appear to converge on one final outcome. The question however appears to concern the cause of that convergence. In the original Copenhagen interpretation of quantum mechanics, the act of measurement was thought to collapse possibility space into a single reality at least with respect to the measured property. It is said to collapse the wave function. That collapse signifies the transition between the quantum and classical realms.

One of the founders of quantum mechanics Erwin Schrodinger formulated a thought experiment to highlight the collapsing wave function in quantum physics (Schrodinger, 1935). In the thought experiment, a cat is in a box with a flask of poison. A machine containing a radioactive element is set to shatter the flask in the event that the radioactive element decays. If the flask shatters, the cat dies. That radioactive decay is a purely quantum process. Until it is observed, it exists in a superposition of states, which means, it has both decayed and not decayed at the same time. The question arises whether the entire macroscopic system attached to that quantum event is also in superposition. If it is the case, then the cat should be

simultaneously alive and dead until the box is opened. An argument can be made that the cat can collapse its own wave function. As from its point of view, the physicist outside is also a quantum blur until the box is opened. The issue that then presents itself is the effect of this supposition on the rest of the universe that is not being observed or measured by the physicists or cats.

In a linear system, the outcome of the cat's life/death and/or the intact/shattered flask could be calculated with a degree of certainty using a mathematical model based on a linear operator. Superposition allows for the prediction of how a system will behave under circumstances that has not been measured. Consequently, if the right set of inputs is selected, the system behaviour and possible outcomes in any condition can be knowable. Since crime scenes contain multiple unknowable items/objects/values, which until measured cannot be ascertained to exist/otherwise, they represent characteristics best described under the header of non-linear systems.

In strictly legal terms, evidence is said not to exist until it is discovered and deemed to be relevant to the proceedings in a criminal case by the judge or panel presiding over that case (Morgan & Maguire, 1936). A crime scene could conceivably contain hundreds of salvageable articles of evidence for the purposes of analysis and subsequent use in criminal prosecution, and in the purely scientific, physical manifestation sense, they can be said to exist. However, until the crime scene investigator locates, documents, bags and tags the items, the forensic scientist analyses it, the prosecution, or defence lawyer introduces it into court, and the judge or adjudicating panel agrees to allow it to be used in the case, those items do not exist in the legal sense of the word.

When a crime scene investigator arrives at the scene, he or she has to determine what if any of the articles present at that scene are of evidential value (Sutton et al. 2016). However, if the rules of the subatomic world are to be embraced, then it can be postulated that in any given scenario, all possible outcomes of that particular situation, has happened, or is likely to happen until measurement, in this case human observation, takes place. Therefore, logic dictates that until a crime scene is processed, it is both of evidential value, and not, at the same time.

When crime scene investigators arrive at a scene, dressed in protective gear, secured by uniformed officers from the outside world, they are tasked with observing and recording details within a demarcated area with little to no perception of the outside world (such as media interpretations or law enforcement hypotheses). One of the reasons for this is the elimination of any potential biases that may affect their ability to remain impartial and objective. The Schrödinger episode illustrates that quantum superposition can be used to describe events beyond the subatomic world.

For crime scene purposes, the example can be as such. When law enforcement arrives at the scene, and an initial determination is made to contact the crime scene or scientific support unit to attend the scene, the investigator arrives with the particular area demarcated as a crime scene, in superposition. This means that it is both a crime scene containing articles of evidential value, and merely a cordoned off area with items of evidence, at the same time. The proverbial collapse of this wave function, occurs when the crime scene investigator through observation and measurement, determines the actuality of the state of the cordoned off area, and its potential value.

Crime Scenes as Complex Non-Linear Dynamic Systems

This basic premise, though indicative of the task at hand, again does not address the characteristics of the crime scene that could determine the evidential value or potential for recovery of evidence. Crime scenes, even those which are isolated and sealed, cannot retain their base properties, or initial characteristics over time. As such, they can be said to be more complex systems of interacting variables, where often, the outcome is determined by external or internal forces unknowable until measured, or unpredictable due to complexity of variable interaction and their results.

Defining complexity in systems is often a complicated undertaking. Commentators have varying definitions and ideas about causality, which is central to the idea of complex systems (Bar-Yam, 1997). It has been described as structure with variations (Goldenfeld & Kadanoff, 1999), a system whose evolution is sensitive to initial conditions or small permutations, a collection of components (Whitesides & Ismagilov, 1999), the intricacy of interfaces between them, the number and complexity of conditional branches, degree of nesting and forms of data structures (Weng et al. 1999), where multiple components are interacting with each other (Rind, 1999) while sharing common theme(s) (Foote, 2007).

Isolated systems tend to evolve towards a single equilibrium — a special state that has been the focus of research for centuries (Li & Sprott, 2014). However, simple periodic patterns of motion are few and far in the real world and behind this complexity is the fact that the dynamics of a system may be the product of multiple different interacting forces that contain multiple attractor states and changes between these different attractors over time could alter the system itself. The nature of nonlinear dynamic systems can be explained by the example of a double pendulum. A single pendulum without a joint will follow the periodic and deterministic motion characteristic of linear systems with a single equilibrium. If this pendulum is taken and a joint is placed in the middle of its arm so that it now has two limbs instead of one, the dynamical state of the system will be a product of the two parts interacting over time and the linear system will react like a nonlinear dynamical system.

Commentators often describe time as a factor when alluding to this non-linearity of crime scenes. Despite never formulating it as such, literature sparingly refers to the effects of time on crime scenes and the evidential items contained within it (Houck et al. 2017). Two of the factors that have principally given rise to this discourse are climate and gravity. For this chapter, climate will refer to temperature, humidity, air pressure, and moisture. Gravity will maintain its Newtonian properties.

Climate and altitude can introduce unique challenges for crime scene investigators too. A scene in the mountains in the middle of winter with the temperature hovering in the 10°F range and after a snow storm has obstacles different than the same scene in spring with the temperature in the 60s. A field in May is different than the same field in late July or September.

Environmental factors have a significant impact on scene processing (Dutelle, 2016). Temperature extremes, odours, and other environmental factors can affect indoor searches. Precipitation, snow, or other intemperate weather may limit the ability of staff in working external scenes. Protective clothing and equipment geared to minimise the effects of such conditions will also affect the visual ability and endurance of practitioners. Concentration and focus can thus be negatively affected with worsening environmental conditions.

Crime scene teams may often be required to search an area for a specific object, rather than conducting a generalized sweep. In such cases, the dimensions of the object will have an impact on the size of area(s) the practitioner can cover. Searching for a bullet shell casing in a manicured lawn is very different to looking for a .32-caliber pistol in the same lawn. As conditions and the circumstances shift at the scene, practitioners will revaluate the size of the search area accordingly. The more compact the area, the better the potential for an efficient search.

Beyond these issues, climate, gravity and altitude play a major role in the way internal and external properties of potentially relevant evidential items come into existence, evolve, are subsequently discovered by crime scene investigators, recovered, and then analysed in controlled laboratory settings. This evolution cannot be explained in any linear model because multiple unrelated and often chaotic factors can affect a single sample.

For example, evidence left at crime scenes undergo various changes, evolution and regression based on the natural and manmade forces that they are subjected to and does not discriminate between intent or happenchance (Lee et al. 2001). The changes to evidence are demonstrably ostensible in biological samples. A bloodstain deposited on a painted wall inside a house can be expected to initially be wet and red in colour. Exposure to the elements and changes within the blood matter itself is likely to clot and dry it. Additional exposure to air may provoke oxidation of the heme molecules in the blood, turning the stain darker, finally settling on a brownish tint.

A blood drop resting on a pavement will further be subject to the diurnal effects of the sun and sharp temperature changes. The colour may shift from red to black in a short period of time. Rain or human interference may degrade the stain even further, likely leaving little to no trace of its existence (Eckert & James, 1998).

Crime scenes therefore fall under the definition of complex dynamic systems which are subject to sensitivity to their initial changes. Commentators in systems studies describe this sensitivity through a hypothesis known as Chaos Theory, which examines the behaviour of dynamical systems that are highly sensitive to initial conditions — a response properly referred to as the Butterfly Effect (Infeld et al. 1997). Small differences in initial conditions yield widely divergent outcomes for such systems rendering long-term predictions impossible in general.

Chaos Theory essentially deals with deterministic systems focusing primarily on simple systems with few elements as opposed to complex systems where many components are non-deterministic (Zeraoulia, 2011). In complex systems, random, complicated and chaotic behaviour is expected, but the same cannot be said of simple deterministic systems. Chaotic and unpredictable behaviour can still occur in deterministic systems (Hilborn, 2000). In this case, deterministic refers to their future behaviour being fully determined by the initial conditions with no random elements involved. The deterministic nature of systems does not always make them predictable because when multiple unknowable variables have the potential to interact with each other due to small fluctuations or changes in initial conditions, it can set into motion a chain reaction which cannot be determined using traditional linear mathematics (Kauffman, 1993).

As discussed above, a double pendulum can be used to illustrate this phenomenon. It essentially consists of only two interacting components. These limbs are both strictly deterministic when taken in isolation. When the limbs are joined together, the simple system can and does exhibit nonlinear and chaotic behaviour. It reveals the source of nonlinearity as the product of the interactions between components within the system. In such chaotic systems, unpredictable behaviour emerges out of the interactions between components. Chaos Theory primarily deals with simple nonlinear systems, but the phenomena of sensitivity to initial conditions is also part of complex systems (Hilborn, 2000). In such systems, sensitivity to initial conditions could be very acute during particular stages in their development during what are referred to as phase transitions.

Commentators refer to these changes to evidential artefacts or crime scene remnants in forensic contexts as the various stages of degradation and decomposition (Haglund & Sorg, 1997; Fiedler & Graw, 2003). Degradation could render key articles of evidence unrecognisable or in some cases completely barren of its evidential value. Nonbiological physical evidence is also

susceptible to change due to time and environmental influences (Gardner, 2011). For example, a bullet/shell casing can change dramatically between its escape from the barrel of a weapon and its recovery from a hard surface. It could have shot through a body, picking up biological material or suffered damage deflecting off bones. The collision and entry into the wall could further change its shape, potentially obliterating microstriae (microscopic, superficial wrinkles that are generally asymptomatic and often only detectable on microscopic examination of bullets). The bullet could even explode or be shattered into multiple fragments, or even become lodged in a human body.

Bullets and casings are capable of accumulating debris if they or the scene remain undiscovered for stretches of time (Wallace, 2015). These alterations can hinder efforts to recognize the items and collate them directly to the crime. Coloured paper left at a crime scene could be altered due to solar exposure, altering its colour; it may get wet and dry again, altering its texture; it may blow away with the wind, challenging scene staff to both find it and recognize it as evidence. The number of variables, their order of impact, the rate at which it affects evidential artefacts seeming chaotic and random can therefore affect the scientific method that laboratory testing is based around.

Limitations of Linear Analysis in Crime Scene Investigation

Scientific analysis can yield its best results in isolated systems, where individual variables can be sequestered, controlled and studied independently. However, in the real world this is literally impossible. Everything influences everything else in the universe (Ervin, 1995), and every single particle of matter has some gravitational effect on every other particle of matter irrespective of how much attempt is made to isolate variables (Kurtus, 2011). The concept of an isolated system that has zero interaction with its environment is merely just a theoretical construct that does not exist in the real world.

Science is however dependent upon the capacity to isolate systems, where cause and effect is studied by controlling variables. No system can be fully isolated. A workaround could be identifying what variables in a system have significant effects and what have negligible effects, and simply disregarding the latter based on its degree of influence. Oftentimes, order in the world is dependent on the dismissal of these chances of the phenomena happening.

In linear systems, the world would seem to be extraordinarily random and chaotic but nonlinear systems (Casdagli, 1992), through its chaos and randomness can grow exponentially through feedback loops. The negligible effects or differences within nonlinear systems can themselves grow in an exponential manner with minor effects and errors feeding back into the system at each stage of its development to compound the size of error as it grows at an exponential fashion.

The effect was described as sensitivity to initial conditions, popularly known as the Butterfly Effect. Lorenz (1972) postulated the question whether the flapping of a butterfly's wings in Brazil set off a tornado in Texas. The flapping wing represented the small change in the initial conditions of the system which caused a chain of events leading to some large-scale phenomena, like a tornado. Had the butterfly not flapped its wings, the future trajectory of the system might have been very different, it was argued. The butterfly does not directly cause the tornado, however. It would be impossible for the flap of the butterfly's wings to do so. It merely defines some initial condition that then sets off a chain reaction through feedback loops that enable a small change in the initial conditions of the system to have a significant effect on its output, rendering long-term predictions virtually Impossible (Feldman, 2019).

The unpredictable nature of the Butterfly Effect means that if the initial measurement is wrong then predictions of its future state(s) can also be wrong (Addison, 1997). This inaccuracy, however will be growing exponentially as the system develops. In nonlinear systems, the starting conditions are unknowable, as the accuracy of measurement must grow in an exponential manner to achieve a linear growth in a horizon of predictability. Chaos and the Butterfly Effect after being shown by the scientific community for many decades is today accepted as scientific fact and are a fundamental and inescapable part of the dynamics to nonlinear systems (Shinbrot et al. 1992; Maldacena et al. 2016). They demonstrate how things can grow exponentially and result in extraordinary and counterintuitive outcomes. It has also been suggested for use in criminological research (Case et al. 2017)

In such non-linear, dynamic complex systems there are a wide variety of variables that hold the potential of affecting the system as a whole. These vary in scope and magnitude. Due to the unique nature of crime scenes, case to case, the variables are often not general enough to illustrate their impact on the larger system, or to explain complexity through chaos theory or the butterfly effect. However, environmental factors such as ambient temperature and humidity, as well as the forces of gravity are capable of demonstrating all these principles. Subtle changes in climate factors can have drastic effects on the scene, and the efficiency of investigation. In order to illustrate this, this chapter will use a widely used method in scientific research — the thought experiment.

Illustrations of the Complex, Nonlinear, Dynamic Nature of Scenes

Thought experiments in the natural sciences afford, or purport to provide information about the physical world without the need to report new empirical data (Brown, 2011). In such experiments concerning modern physics, the premise of the arguments is generally held within one or other physical theory. Thus, a thought experiment might be a purely deductive derivation within some physical theory. But not all such thought experiments are deductive. Some do

involve inductive reasoning or the introduction as a premise of a general philosophical principle not contained within any specific physical theory. They possess the advantage of being able to assist in reaching conclusions regarding hypothetical ideal environments with unlimited variable tweaking without the need to reset or restart the experiment. The underlying laws can simply be applied gainfully to more complex, real-world situations.

The Hypothetical Scene

For the purposes of this first thought experiment, the reader is tasked with imagining a small, closed space. The scene of the crime would be a 15-feet by 15-feet room temperature-controlled, completely scrubbed of any biological, and/or non-biological traces. The room is completely sealed, with no windows or exits, other than a single metallic door. For all intents and purposes, the room would be a fully sanitised area — a blank slate. It is important that this room possess these primary characteristics, free from any contamination. The object of the thought experiment would be defeated if the variables inside the room were plentiful to the extent that they could not be controlled in any organised manner. Limiting the variables is thus, a necessity, rather than choice.

Crime scenes are said to be a result of cause and effect (Chisum, 2011). The fewer the incidents, the logical assumption would be that their effects would be, in correlation, limited as well. In the imagined room, there are two biological entities. Two men of average height and build standing face to face. The first man (X) is standing two feet away from the door. The second man (Y) is further across to the end of the room, two feet away from the back wall. X pulls out a Glock 17 handgun from his side and fires two projectiles (9×19mm Parabellum rounds) at Y. Projectile 1 (P1) is a through-and-through Y's skull and lodges itself into the back wall. Projectile 2 (P2) enters Y's body through the abdomen and is stopped by his vertebrae. Y drops to his knees and falls to his side — which is his final resting position. X drops the gun on the floor. X turns around, opens the door and leaves the room, closing the door behind him.

Upon arrival at the scene, the crime scene examiner (CSE) checks the legal basis for the search, and upon confirmation, dusts the door handle on the outside of the door, for fingerprints. This would be considered standard practice (LeMay, 2016). The door is photographed from the outside, and then carefully opened. The CSE stands outside the door, peering into the room to formulate the search strategy for evidence (Baber & Butler, 2012). As the room is completely sanitised, concerns about primary and/or secondary contamination can be eliminated. However, the state of the evidence, the body and the recoverability of both can be drastically affected, with the just one variable being added — climate. A non-exhaustive account of the potential effects of small changes in climate factors to this otherwise seemingly isolated system can be summarised as follows:

Fingerprints

The environment and the length of time a fingerprint is exposed to that environment affects its integrity and the subsequent recovery strategy of the investigator (Champod et al. 2016). Heat, humidity, pollution, UV radiation, dust, and time affect the print quality. It is important to understand why and how the environment plays a critical role in the integrity of the fingerprint residue because it can dictate which method has the best chance of success. If it is hot and humid, dusting or superglue fuming may have the best chance of success. If the temperature is moderate, 50°F, and the humidity is between 20% and 90%, the same may be true. If it is winter and the humidity is low and the room overheated, the print could be dry (dehydrated print residue) and unresponsive to traditional dusting or even superglue fuming. The scene practitioner will realize this is a possibility. Studies designed to explore the superglue fuming reaction in eccrine prints has shown that lactate in the residue is the initiator of the superglue fuming reaction. In fact, if lactate is gone, whether because of excess heat (>50°C) or from UV radiation, superglue fuming will not work (De Paoli et al. 2010).

The composition of the surface on which the print is initially deposited, also plays a major part (Champod et al. 2016). Because they absorb fingerprint residue, porous surfaces are treated differently from nonporous ones. Papers absorb fingerprint residue to varying degrees and amounts, which is determined by the paper's absorption characteristics as well as other absorption effectors such as humidity, temperature, and the environment. For this reason, porous surfaces can be classified into groups based on how quickly they absorb print residue.

Impression Evidence

Humidity has been studied with regard to a similar technique using an electrostatic detection apparatus (ESDA) for the detection of indented writing (Pearse & Brennan, 1996). Studies have shown that there is a broad range of acceptable humidity, but when the relative humidity rises above 98% at room temperature the quality of the print drops. At cold temperatures, lower humidity also causes a decrease in the quality of the highlighted indented printing. While the ESDA technique is not identical to electrostatic lifting, the principle is, and one might expect similar deterioration of the quality of lifted impressions using an electrostatic lifter. Using electrostatic lifters under normal conditions of temperature and humidity would ideally produce good results. If the humidity is too low, there are issues with recoverability of prints. The ESDA process requires humidity, which opens the possibility that the absence or near absence of humidity may also affect the quality of electrostatic lifts (Allen, 2015).

Blood

Temperature, air flow, and humidity affect the time it takes for blood to dry (Eckert & James, 1998). Knowing how long blood has been at a scene can help determine when the crime took place. Drying times for blood are impacted by the temperature, humidity, air currents, and surface on which the blood has fallen. Bloodstains dry from the perimeter inward, and small spatters will typically dry within about 15 minutes. Skeletonized stains occur when the perimeter of the stain has dried, and the centre has flaked way, leaving the visible outer ring (Bevel & Gardner, 2008). In our scenario, the blood pool, the stains and the spatter on the wall would all fall victim to degradation due to even one of these factors.

Biological Entities

Three general categories of postmortem changes occur in the real world: early, late, and tissue (Haglund & Sorg, 1997). Death brings about obvious acute changes such as loss of vital signs (pulse, respiration) in addition to short-interval changes. Longer intervals lead to delayed changes of decomposition (Spitz et al. 2006). Temperature can have a significant impact in this. Generally, heat accelerates the postmortem reaction, and cold delays it. Another confounding variable is the physical location of the body. A crude estimate is that one day on land is equivalent to one week in the water or one month buried, but all could be affected by the state of the body, including premortem and postmortem wounds, exposure (clothing, wrapping, etc.), temperature (extremes), and a host of other factors (Houck, 2017). Biological systems have myriad internal variables that combine with the variety of external conditions. This adds to the complexity.

Experience of the medicolegal investigator/examiner (ME) is therefore vital (Timmermans, 2007). It is important to understand how variables may be important in explaining the conditions observed at autopsy. If relevant information is not adequately documented, it could significantly impact the subsequent opinions formed (Prahlow & Byard, 2011). The net effect could lead the ME to a perfectly logical but completely erroneous cause and manner of death determination. The early changes of death manifest itself as: cessation of respiration, cessation of circulation, skin pallor, muscle relaxation, eye changes (both the cornea and retina), and blood coagulation/fluidity (Guharaj, 2003). Later changes include the classic indices of death, i.e. rigor mortis, livor mortis, and algor mortis.

Algor mortis, or the cooling of the body following death, can be crudely estimated. At average ambient temperatures of 70°F 272°F, the body loses heat at a rate of approximately of 1.0°F to 1.5°F per hour until the body reaches the ambient or room temperature. Such a calculation assumes a normal precise starting temperature, which is seldom the case. This is an example of the nonlinear characteristics of crime scene artefacts. Temperature changes are affected by the

deceased's health (e.g., an infection such as pneumonia may change the subject's baseline body temperature—up or down). *Perimortem* (taking place at or around the time of death) circumstances are also important, for example, an extreme struggle or exercise might produce a fever while prolonged shock could lead to an abnormally low temperature. Environmental temperature is an important consideration as well (Mozayani & Nozigilia, 2010). Body temperature may rise after death due to residual tissue metabolism and normal bacterial activity and may remain elevated for several hours.

For instance, if a person dies with the average body temperature of 98.6°F in a 68°F room, there will potentially be a 17-hour window when the time of death can be roughly estimated. But research has shown significant variables: a thin body cools faster than a fat one; the larger the surface area to weight ratio and the less subcutaneous fat, the faster the cooling process; whether the body is sprawled or curled up will have an impact; clothing will affect the cooling; shade or sunlight; in the shallows or beside a river (Nokes et al. 1992; Henssge et al. 2000; Madea & Kernbach-Wighton, 2017).

Lividity (colour changes in skin due to settling or pooling of blood) continues to form for up to eight to ten hours after death, at which time it will be maximal (Bennet & Hess, 2006). If the body is cooled, this process can be slowed at a temperature-variable rate, and thus it may take 24 to 36 hours in a cool environment or perhaps even longer in a morgue refrigerator. Again, climate factors are key (Wagner, 2017).

During the period in which rigor mortis is still forming, if sufficient cellular chemicals remain, it may re-form after it has been broken. This principle is often utilised to help with estimating the postmortem interval (Dix & Graham, 1999). *Rigor mortis* can be broken in one extremity at the scene (test) with the opposite left as is (control). The areas are then reevaluated in the morgue to determine the extent to which rigor mortis has changed in the defined interval between body recovery and postmortem examination (Payne-James et al. 2003). Once the involved elements are depleted, the reaction reverses and it disappears or passes. This is again, very much temperature dependent. In hot environments, rigor mortis may pass within 24 hours (earlier if there was cadaveric spasm to begin with), whereas in colder climates and/or refrigerated bodies, rigor mortis may persist for up to a week or possibly longer. Freezing the body stops the chemical reaction, but the postmortem changes are accelerated after thawing due to microstructural damage associated with ice crystals (Waters, 2010). The specialized descriptor of cutis anserina refers to goose bumps seen in a deceased body. These are the result of rigor mortis affecting the small muscles attached to individual hair follicles.

Tissue changes occur later, usually at 24 or more hours after death, and are time, temperature, climate, and environmentally driven. While most often individually described, all these changes

occur at variable and overlapping rates and may even be visible simultaneously in any one body. The major tissue degradation processes are decomposition, mummification, adipocere, and skeletonization (Iscan & Steyn, 2013). However, rigor mortis would be an unsuitable method if the victim had been dead longer than 36 hours because the condition disappears after this time. Livor mortis ceases 16 hours after death, so it would be of limited value in estimating the time of death after this period has elapsed. Algor mortis would not be an accurate method for estimating the time of death if the body was stored in a particularly hot or cold environment because extreme temperatures would affect the rate at which the body lost heat (Dix & Graham, 1999). Therefore, changes in just one factor can have a drastic impact on the body, derailing an investigation.

Decomposition suffers from similar issues and involves two simultaneous processes in autolysis (self-digestion by released cellular enzymes) and putrefaction (microbial destruction) (Oxenham, 2008). Factors influential in decomposition include once again, the environment, clothing, temperature, humidity, light, covering, location, and so on.

Entomology

Forensic entomology is the utilisation of insect and anthropod information in legal processes including cases of medicolegal, stored product or urban circumstances (Catts & Goff, 1992). Insect activity happens at a rate that is proportionate to temperature meaning that, between the upper and lower thermal limits for development of any species, lower temperatures will result in a longer period of development while warmth will result in a shorter periods. As such, estimation of the temperatures at which the insects collected from the body develop is crucial (Byrd, 2002).

There can variations in temperatures even between locations separated by short distances because of environmental factors. As a result, forensic entomologists do not rely on simple temperature measurement data from weather stations. Hourly temperature readings are taken at the scene for a lengthy time period, up to ten days utilising digital temperature dataloggers at the location where the body was located.

It is followed by a regression analysis of the temperatures at the scene and those recorded at the nearest weather station. The temperature at the scene before discovery of the body, to the time of last confirmed sighting of the victim when he/she was alive, can be estimated by using the regression algorithm to the hourly readings from the weather station.

Latent prints off skin

FBI (1996) found that the bodies of homicide victims could be examined for latent fingerprints. Ideally, such examination take place at the morgue prior to any refrigeration of the body to

locate prints that might be destroyed through the cooling of the skin temperature or by the moisture that naturally occurs through the cooling process (Mulawka, 2014). However, latent prints are very fragile and easily lost or damaged by friction, moisture, or cross-contamination by liquids (water, urine, blood, or other bodily fluids). Any of these problems can occur to a body placed in a body bag for transport to a morgue. In some instances, the examination should therefore take place in the field to prevent the potential loss of critical physical evidence.

Oftentimes, the crime scene investigator must make that determination in collaboration with the medical examiner. The body would have to be at room temperature for maximum success, but it is possible to locate latent prints after refrigeration. To do so, condensation that may have occurred on the body will need to evaporate before attempting the fuming process. Frost-free refrigeration would be best for preserving latent fingerprints on skin because it would keep the sebaceous oils of the latent prints from melting on the victim's skin (Fish et al. 2013).

These examples illustrate to what extent the evidence can change in the course of a crime being committed, a crime scene coming into existence, its metamorphosis phase, being discovered, and then finally processed by practitioners. The chaotic nature of this nonlinear, complex, dynamic system is evident in the effect that one variable (in this case, temperature/climate) can have on everything from fingerprints, to impression evidence, to insect activity, to degradation and decomposition of the biological entity.

The entire characteristic of the crime scene can thus be altered, with just one variable change. As stated earlier in the chapter, gravity also plays a major part in crime scene processing. In order to examine just how much this particular variable can affect the scene, the hypothesized crime as described above would be relocated in a chamber inside the Earth-orbiting International Space Station (ISS). This change alters the nature of the scene in surprising ways.

Gravity

As the bullet (P1) goes through Y's skull, on Earth, there would be a high velocity blood spatter (based on the weapon used by X) on the back wall. The second bullet (P2) would leave a pool of blood on the ground. Any shift in the gravity variable would also change the manner in which blood evidence and projectile fragments would react. In microgravity, for example, liquids ball up and float around, restrained only by their surface tension, and blood pressure decreases resulting in loss of around a fifth of blood volume. The physics of space would not allow for the same blood spatter patterns as seen on Earth. The likelihood is that blood would form spherical shapes like other liquids, either sticking to the victim or floating away from their source. More advanced theoretical blood analysis models have been formulated in recent years (Comiskey et al. 2016) but this is unlikely to assist in microgravity. As such, reconstructing a crime scene from spatter pattern analysis would be incredibly complicated. The current

mathematical equation used for such analysis would need changing to account for gravitational difference, and even then, it would be of little reliability due to the fluid dynamics of space.

When a blood droplet leaves the human body under a force, it forms an arc, a path described mathematically (Eckert & James, 1998). The droplet represents a projectile and its path is its trajectory. Much like a bullet, the shape of the arc a blood droplet takes to its terminus depends on gravity, wind currents, temperature, humidity, and friction (Rivers & Dahlem, 2014). In the absence of these external influences, the arc described by the blood droplet's path would be a parabola defined by a uniform, homogeneous gravitational force field. In the real world, such a singular effect is non-existent. Air resistance (friction), drag, and nonuniform gravitational forces exert their influence on the path. So, in the real world, the path the droplet takes is not a true parabola, its trajectory reflecting the influences of drag and gravity.

The position of a shell casing can usually indicate where a shooter may have been situated when a weapon was fired (Gardner, 2011). However, in space, with no air resistance or gravity, the ammunition's casing expelled from the weapon would float away at speed. Fired at close quarters inside a spacecraft, a bullet could pass through the human body, through any bulkhead walls and continue to travel for vast distances through space. Without casing or bullet, it would be a challenge to produce any useful ballistic analysis.

X opens the door and leaves the room. There could be potential touch DNA, and fingerprint evidence for the crime scene practitioner to collect. Fingerprinting uses carbon or metal-based powders which stick to the moisture of prints left on physical surfaces, or through a method called superglue fuming where cyanoacrylate is heated in a container, and the resultant fumes bond with fingerprints on objects placed inside enclosed containers. Space physics means a method requiring enclosed spaces wouldn't be a viable solution in a spacecraft, while a phenomenon called particle agglomeration, where particles such as dusting powder stick together, could render dusting techniques hard to implement in microgravity. Traditional collection means would thus, fail.

Any footprint evidence from X may not survive, as he may not have been on an upright position on the floor to fire the weapon. Y's final position would also be different, as due to microgravity, his body could float away to a place misrepresentative of where he was shot. The gun would also be subject to the same forces.

Livor mortis (lividity) is a physical process by which the colour of the skin darkens due to time-dependent gravitational settling of the blood within the capillaries (Wagner, 2017). Although the process starts immediately with death (or, rarely, could start before death if there is markedly low blood pressure), it is generally not visible in the first 30 minutes. Most observers should be able to appreciate livor mortis within two to four hours of death. Gravitationally

dependent dark areas surround the area of the body in contact with the resting surface. The latter appears pale or blanched because the small vessels are compressed, precluding blood from settling there. Likewise, tight clothing or body parts may restrict the settling, leading to a corresponding pattern on the body.

Notwithstanding these non-human factors, there are a multitude of unpredictable human factors which can add to the chaos and complexity of crime scene investigation. As human intervention (intentional or otherwise) in the form of both acts and omissions are also variables in the formulated hypothesis of viewing crime scenes as systems, examination of this aspect is important.

Human Factors

A perfectly preserved crime scene in a sealed environment can be contaminated and/or disrupted if the first responding officer does not follow proper procedure (Lee, 2001). Opening windows at the scene and leaving the door open for longer than necessary could also have an impact. Improper walkthroughs, and not wearing protective gear could destroy potential evidential artefacts (Matisoff et al. 2011). Witnesses can also contaminate scenes, making it difficult for examiners. Crime scene staging, where the perpetrator(s) or another moves around evidential artefacts (including the body) as part of the crime, or later for some other purpose (Santtila et al. 2001). All of these factors contribute to multiple variables, in a complex, dynamic, nonlinear system, i.e. the crime scene.

CONCLUSION

There is great misunderstanding in the exact nature and scope of crime scene work and the contribution of its practitioners to the criminal justice system. There are many realities which converge in the courtroom, particularly those involving jurors and their misrepresented understanding of forensic science and crime scene practice. One of the primary concerns of this thesis is to present an accurate and revelatory portrayal of scene work, in order to facilitate better policymaking and practice. Early on in this thesis, it became evident that scene work has not been defined in terms that its many nuances could be explained in a scientific manner. Limited studies examined the many factors which were capable of complicating scene tasks, with some concluding without going into detail, that practitioners have to contend with a multitude of factors in order to get the job done. However, generalized conceptualizations of specific scene challenges contribute little to the wider argument that crime scene work is much more than manual labour. The argument put forward in this chapter is that the discipline involves comprehension of natural phenomena, and appreciation of the impact of physical, chemical and biological forces on the evidence at the scene.

Conceptualisation of crime scenes beyond merely spaces where crimes have taken place has real-world benefits, in that, it can assist crime scene investigators better process scenes, crime scene managers plan evidence searches and recovery attempts more effectively and inform stakeholders the complexity of the work undertaken by scene practitioners. An important issue that this conceptualisation addresses is the claims by commentators that crime scene investigation is not scientific because it does not rigorously adhere to the scientific method. Most scientific methodologies follow linear principles of cause and effect, whereas crime scenes, in themselves, are nonlinear. In addition, they are complex and dynamic making them almost impossible to analyse in linear terms. The interaction of multiple unknowable variables, non-adherence to the rules of superposition, and sharing characteristics with chaos theory are factors which set it apart from the traditional scientific method. But this does not automatically relegate it to being non-scientific.

Crime scene investigation/examination is a form of systems analysis which requires, as this chapter has illustrated, understanding of scientific principles of physics, chemistry, biology, legal principles of warrants, search and seizure, admissibility and evidential relevance, as well as anticipation of the unexpected in an unpredictable system of shifting, unknown variables, which only become apparent upon observation and measurement. The question it sets up for the ensuing chapters is whether these facets of crime scene work are reflected in the expectations placed on them by law enforcement, the investment made by the state, and the support it receives from state and private entities in fulfilling the role(s).

Acknowledging the complexity of scene work, and the breadth of the role can also produce better quality control, and quality assurance strategies in the field. The existing strategies, and recommendations for future innovation in the area is examined in Chapter Seven.

Conceptualising crime scenes as a complex system which is a sum of its parts, rather than fragmented traces on a canvas, can also lead to better documentation of scenes. Courts have traditionally relied on forensic science units to produce visual evidence in court as an alternative to crime scene visits. Crime scene investigators (CSIs) gather and use evidence to recreate the precise sequence of events that occurred during a crime. Part of this reconstruction process is photography and sketching, with the latter still largely done by hand.

Photos give a limited picture of the crime scene, restricted by the photographer's field of view and subject to their interpretation of the scene and the importance they place on different pieces of evidence. Video can capture more of the scene but is still limited in its field of view.

Sketches lay out the scene in a way that neither photographs nor videos can. They provide a general overview of the scene and the precise and relative location of evidence. But they also give an inherently less realistic representation of the crime scene, determined even more by the

artist's interpretation. Similarly, photos and videos can be turned into 3D computer animations but again are subjective and can even be tailored to support the case of whichever side is presenting them.

Viewing crime scenes as a system of interacting variables can lead to a more comprehensive documentation methods, such as 360° photography and videography. These could inform juries in a more complete and succinct manner with the potential of adopting technologies such as virtual reality, and augmented reality.

The biggest takeaway from this chapter should be the complex nature of scene work, and the knowledge and understanding of not just human behaviour, but shifting natural and environmental properties which in turn have a knock-on effect on everything at the scene. Under austerity regimes, where replacement of human workers through mechanisation is a policy consideration, the information contained in this chapter could be a useful reference for policymakers to understand the challenges a machine would face, and the magnitude of the task before it, if automation were a consideration for cost-cutting.

Remaining on the subject of austerity, as it is the thread that runs through this thesis consistently, the next chapter will outline the methodological considerations and the chosen methods for examination of scene work, and how austerity policies potentially impacted the finances, numbers and responsibilities of scene practitioners in the United Kingdom from 2009 to 2015.

CHAPTER FOUR

CSEs in the United Kingdom are generally understood to be civilians and the role is present in each self-governing police service in the jurisdiction (Wyatt, 2014). Their job titles and the specifics of occupational requirements differ from force to force, but roles and responsibilities can generally be considered similar (Williams, 2008). They can be thought of as regular fixtures within the police investigative mechanism, and their influence on popular culture is very much noticeable. Surprise has been expressed on the limited number of studies of the day-to-day work of crime scene practitioners and especially their roles the crime scenes (Wyatt, 2014).

Commentators acknowledge the significance of crime scenes and the investigation of these spaces (Horswell, 1995; Horswell & Edwards, 1997; Ribaux et al. 2010b; Kelty et al. 2011; Julian et al. 2012), but the non-specific, generalised nature of these enquiries has eluded the examination of any depth, into these matters. Studies have been conducted on the key attributes thought to be common amongst top scene examiners (Kelty, 2011; Kelty et al. 2011), the scientific nature of scene examination (Millen, 2000; Harrison, 2006) and the perceptions of their role(s) (Ludwig et al. 2012). Notwithstanding the importance of such research, at least regarding the macro aspects of the crime scene examiner/examination role, their focus on overarching issues often eludes consideration of the crime scene work or its practitioners in any significant depth.

Wider sociological literature on forensic technologies can be found to often disregard the CSE instead, putting most, if not all attention on law enforcement usage of forensic science in terms of the development, implementation and governance of DNA technologies and police DNA databases (Hindmarsh & Prainsack, 2010; McCartney et al. 2011), the effects of the privatisation of forensic science provision (Lawless, 2011; Lawless, 2016) and the discourse surrounding the forensic/scientific expertise in courtrooms. Fingerprint examiners receive a share of this attention (Cole 2001, 2005) and the rest often goes to laboratory-based forensic practitioners (Halfon, 1998; Jasanoff, 1998; Lynch, 2002; Lynch et al. 2010).

Published records from official sources is generally unhelpful to determine the number of crime scene investigators in the United Kingdom at a given moment, nor are the finances specific to crime scene examinations/examiners the subject or content of publication. Police Workforce Data 2015 lists the following ‘police worker’ type: (1) police officers (61.2%), police staff (30.8%), police community officers (6%), and designated officers and traffic wardens (2.1%) (Home Office, 2015). The breakdown of these figures does not assist in understanding which of these categories, if at all, crime scene examiners belong to:

Table 4.1: Police workforce, as at 31 March 2015, England and Wales

Rank	All staff (FTE)	Staff available for duty (FTE)
Chief officers[2]	201	200
Chief superintendents	337	332
Superintendents	820	808
Chief inspectors	1,657	1,625
Inspectors	5,701	5,548
Sergeants	19,148	18,511
Constables	98,954	94,053
Total police ranks	126,818	121,078
Police staff	63,719	61,073
Police community support officers	12,331	11,719
Designated officers	4,254	4,122
Traffic wardens	18	17
Total police workforce	207,140	198,009
Special constabulary	16,101 (headcount)	-

As the general understanding is that crime scene and forensic science practitioners are often civilians in the UK (Wyatt, 2014), police staff could refer to personnel outside of the designations listed above. Civilian staff have also been described as those who are not 'uniformed officers' (Adetunji, 2010). However, with no official designation or description available, the numbers are difficult to ascertain. The disbanding of the CRFP (discussed in the Chapter One) has meant that there is no official source to derive forensic science specific data. The office of the Forensic Science Regulator (FSR) is not subject to the Freedom of

Information Act 2000, nor are the relevant HR and financial data published. The Home Office and FSR only have partial access to performance data, service quality and management information, quality management and accreditation, and the physical security of evidence in the forensic service providers' custody (NAO, 2014: 6). Neither body has the ability to compel any provider to relinquish quality assurance data, and even police forces are not obliged to provide this information (p. 7). The data that does get collected relates to police force expenditure, market information through the Forensic Management Information Tool (FMIT), supplier monitoring data such as turnaround times, accreditation status (of laboratories), and organisational financial health (p. 5) — none of which are comprehensively compiled. NAO (2014) figures do not list the financial contribution of the government to crime scene investigation, nor does it list the practitioner numbers, their designations or their roles within the police organisational structure.

Any value judgment regarding crime scene investigation, and crime scene examiners by extension cannot be made without these figures. The constructed reality of forensic practitioners cannot thus be said to be one based on irrefutable facts, as the information available to stakeholders is limited in its scope. Anecdotal accounts through interviews can provide a perspective on the issues but backing them up without the numbers is a challenge. Surveys and questionnaires could afford a rich source of quantitative data for the purposes, but a project of that magnitude would be impractical for a single doctoral researcher. There are gatekeeper/access hurdles, non-participation, incomplete participation issues, and data collection and analysis problems to contend with. It therefore was imperative that research design be a careful consideration for this project, as it would determine the likely success or otherwise of the data gathering process in use. A system was required whereby access to the relevant data could be sought, where access problems could be managed through legal provisions which would compel the data hub organisations to comply. Among the more conventional and widely used methods was the seldom utilised documentary analysis through the freedom of information technique. The dynamics of which, when considered, are of research significance itself.

Freedom of Information: An Introduction

Freedom of speech and expression has endured a long journey from ancient times to the modern world. From the demands of the right to express oneself, to the innovation of the free press, the culmination of the 21st century information society, and the digital world it is encapsulated in, the world has seen a plethora of development towards a mechanism of state accountability.

Mechanisms exist in the social sciences for the discovery and utilisation of data that is generated by state entities such as its investigative, legislative and judicial arms. Freedom of information (FOI) is among the sources available to social scientists around the world, following a string of data democratisation attempts by governments since 1766. Such methods for information gathering have been used by anthropologists as a means of archiving materials as a primary source of information, supplementary to field work.

Robust FOI legislation around the world bear commonalities, such as the presumption that citizens have a right to public documents, rather than weak FOI provisions, which shifts the presumption to the state's right to determine whether to grant access to the information-seeking citizen. The exceptions in strong FOI laws are limited in its restrictive stipulations, with limitations set only for state security and legitimate privacy concerns, rather than the government's blanket right to exempt documents from release (Kirtley, 2006). Legal provisions in robust FOI mandates also provide for a third-party mechanism for access-related dispute resolution.

FOI laws are considered to be the gateway legislation to effective e-government policies, campaign finance disclosure regulations, and electronic procurement systems, among other state policy innovations. It is thought that reduction of information asymmetries could lead to promotion of greater economic transparency and stability, while encouraging more well-thought-out public policies. Such innovations are theorised to improve communication between different branches of government, the citizen and the press. Accountability is also a possible by-product of strong FOI legislation. The object of these laws is to render states more professional, predictable, and accountable, and its citizens more proactive in public sector matters (Rhodes, 1997).

The advent of access rights to state-held information and its impact on governance and policy are a recent development. The significance of the legislation concerning the openness of these laws relates to state bodies being seen as information centres, where the information they hold is a source of power and influence.

Freedom of Information in the United Kingdom

Freedom of Information legislation came into effect in the United Kingdom from 1 January 2005. The two Acts of parliament relevant to the enactment of FOI are the Freedom of Information Act 2000 (FOIA), which applied to the UK, excepting Scotland, and the Freedom of Information (Scotland) Act 2002 (FOISA) which came into force in Scotland. The Acts are similar in their provisions, to the extent that they will collectively be referred to as United Kingdom Freedom of Information Laws (UKFOIL) or the Acts. The differences will be

highlighted, where needed. The Acts refer to specific and broad obligations placed on public bodies and codes of practice for the enforcement of the same.

The trend over recent years has been a lack of dedicated resources for records and information management at public sector institutions. This has been evidenced by a general lack of skills that has seen the re-evaluation of information systems at these organisations since the enactment of the UKFOIL. The data administration practices and their real-world impact on information freedom is important not only from a position of perceived democratic virtue, but also from a business perspective for public bodies. Compliance with UKFOIL is therefore, a matter of practical relevance, as opposed to merely an ideological one.

UKFOIL affords a general right of access and/or entitlement to publicly held information, assigning two core duties on public authorities:

- to produce and maintain a publication scheme— a document that details the classes of information that an organisation will routinely make available.
- to process requests for information held by the requested authority, in 20 working days. The authority has to fulfil a number of obligations in that period.
- in the majority of cases, to confirm whether or not the information is held (although, this is not a specific duty under the FOISA).
- to provide the information if it is held by the authority, unless it is subject to an exemption.

Despite the increased awareness of UKFOIL, there has been little academic study of its objectives. Academic studies of FOIL in other countries examined such aspects. Cain et al. (2003) examined the expansion of FOIL mechanisms across advanced democracies, focusing particularly on the USA, Italy and France. The study outlined a number of the objectives of FOI arguing that greater participation in policymaking requires more knowledge of government and as an extension, more transparency.

Lord Steyn (2001) and the Lords Constitution Committee (2004) heeded particular prominence to the Explanatory Notes to trace the legislation's objectives. Explanatory Notes of the UKFOIL refer to the 1997 White Paper as a source to ascertain the purpose of the Act (Home Office, 2000). The objectives set out in the White Paper are therefore given due consideration. Lord Falconer (2005) proposed consideration of three performance indicators: the public body(s) compliance; the citizen's experience of making use of the law, including whether it assisted citizens in making decisions about public services; and perceptions of the impact of the legislation itself.

James (2006) found ten possible objectives of FOIL, which was listed with a disclaimer that it was not an exhaustive list:

- Increased transparency
- Encouraging participation in government matters
- Enhancing the quality of decision-making in government
- Allowing citizens and organisations to uphold their rights
- Boosting public confidence in the governmental process
- Raising the effectiveness of public administration
- Increasing the accountability of the state
- Safeguarding probity
- Increasing the effectiveness of the press, and media
- Advancing a more open culture within public service

Hazell et al. (2010) listed the six most frequently mentioned objectives in the official British literature:

- Increasing the openness and transparency of the state
- Increasing the accountability of government
- Improving the quality of state decision-making
- Raising public understanding of government
- Boosting public trust in public bodies
- Increasing public participation in government.

These characterisations of the objectives are key to formulating a strategy to evaluate UKFOIL in the instant study.

A Timeline of Key Developments in UKFOIL

Table 4.2	
Administration: Harold Wilson (Labour) 1964–70	
1966	The Fulton Review (1968) recommends exploration into minimising unnecessary state secrecy
1967	Wilson reforms the 50-year rule on records release, reducing the time period to 30 years.
1969	'Information and the Public Interest', an influential White Paper tackles the matter of secrecy but does not endorse any specific reforms (Cabinet Office, 1969)
Administration: Edward Heath (Conservative) 1970–74	
1971	Franks review of section 2 of the Official Secrets Act 1911 keeps the issue of secrecy on the public agenda
1972	The Local Government Act is enacted allowing for the access to some of the core decision-making processes of local government
Administration: Harold Wilson (Labour) 1974-1976; James Callaghan (Labour) 1976-1979	

1974	Labour's manifesto commits a future Labour government to a freedom of information legislation, and the repeal of the Official Secrets Act 1911. The pledge features in every manifesto until 1997
1975	The Labour government rejects FOI legislation and the government explores other options to promote openness
1977	The ambit of the Official Secrets Act 1911 is reduced through a change in prosecution policy
1978	The Croham Directive attempts to elevate openness through a voluntary release of information, particularly background evidence used in public decision-making
1979	The government's Green Paper on open government (Cabinet Office, 1979) claims to remain open minded on the possibility of FOI legislation in response to Clement Freud's Official Information Bill. The Bill eventually fails when the government falls in April, and Parliament is dissolved
Administration: Margaret Thatcher (Conservative) 1979–90	
1984	The Data Protection Act brings access rights to personal information held on computerised records
1985	The Local Government Act further increases access to local government decision-making
Administration: John Major (Conservative) 1990–97	
1992	Environmental Information Regulations come into force, allowing access to environmental information under EU Directive
1993	Mark Fisher's 'Right to Know' Private Members' Bill gains cross-party traction but runs out of time for enactment
1994	John Major's 'Code of Practice on Access to Government Information' comes into effect across central government, enforced by the Parliamentary Ombudsman
Administration: Tony Blair (Labour) 1997–2007	
1997	The Cabinet Office releases the FOI White Paper, 'Your Right to Know' in December (Cabinet Office, 1997).
1999	The Home Office publishes the draft Freedom of Information Bill and consultation paper in May (Home Office, 1999). The draft Bill undergoes pre-legislative scrutiny by the Commons Public Administration Select Committee and a Select Committee in the House of Lords
2000	The Freedom of Information Act receives Royal Assent in November
2005	The Act comes into force across more than 100,000 public authorities in January

Research Studies Using FOI

Research studies have been conducted on the introduction and adoption of freedom of information legislation around the world. Studies have covered almost every continent on the planet, including South America, Asia, Africa, Europe and the Middle East. Cross-national investigations have focused on the implementation of such laws, and the governance of the countries adopting the same. The strength of news media rights, and geographic contagion are largely unexplored areas, though.

The need for a more substantial body of work, conducted in a systematic manner has been recognised, across jurisdictions. Intergovernmental bodies such as the European Union (EU),

the Organisation for Economic Co-operation and Development (OECD), United Nations Development Programme (UNDP) and the World Bank, along with non-state actors like the Open Society Institute have called for robust FOI legislations around the world (Ackerman & Sandoval-Ballesteros, 2006). However, enactment of such laws for the mere purpose of quelling international pressure, renders these mere paper laws — ineffectual and free from any purposeful impact (Open Society Justice Initiative, 2006; Relly & Sabharwal, 2009). The importance of investigation into the administration of FOI legislation, and the evaluation of their provisions and effectiveness is thus accentuated (Islam, 2003; OECD, 2005). Research in the area is limited to the point, where UK FOI legislation, is yet to be extensively evaluated. It was, as such, a necessity for this study to examine these provisions, and add to the knowledge base of this form of data collection in social science research.

Usage

According to the Cabinet Office (2016), there were 45,415 FOI requests received across all monitored bodies in 2016. It was a decrease of 1,971 (-4%) on 2015 levels. Across all monitored bodies, 91% of requests were responded to in time, up from 90% in 2015.

Of the 45,415 FOI requests received, 33,337 were resolvable. Of these 46% were granted in full, and 37% were withheld in full. This was a decrease of 1.6 percentage points for those granted in full and an increase of 1.6 percentage points on those withheld in full on 2015. The remaining resolvable requests were not yet processed or were partially withheld.

Of the 17,128 requests withheld in full or in part, 29% were withheld due to the cost of response exceeding the statutory limit, 2% were withheld as vexatious or repeated, and the remaining 69% fell under other exemptions.

During 2016, Department for Work and Pensions, Ministry of Defence, Ministry of Justice and Home Office made up the four largest Departments of State in terms of number of FOI requests for the third year in a row. Combined, they made up over half (53%) of FOI requests made to Departments of State. New departments BEIS, DEXEU and DIT together accounted for 3% of Departments of State FOI requests. The Health and Safety Executive and The National Archives accounted for over half (51%) of requests to other monitored bodies.

There is, however, limited information on the total number of FOI requests made under UKFOIL to law enforcement organisations, and their eventual outcomes. Organisations have individual publication schemes by which requests, and their outcomes are released for public access, but these are subject to the discretion of the individual bodies.

Nuances of Foil as a Research Method

The UKFOIL provisions should be of particular interest to the criminological researcher whose agencies of study are often data-rich, but reluctant to publicise. The UKFOIL system covers a wide range of criminal justice agencies including the Home Office and the Ministry of Justice; the Crown Prosecution Service; all 43 police forces (England & Wales); state-run prisons; and the probation service.

It is not clear to what extent academic researchers are making use of UKFOIL as a resource for data collection. The Ministry of Justice, which collates the data on FOI, does not provide a breakdown which would categorise the requests and responses by information seeker. Studies from other jurisdictions suggest that FOIL is used very little by the research community. It is not known about who in the academic community uses the FOIL or how it is utilised. With the exception of historians, researchers have been found to make very little use of FOIL (Lee, 2001). This trend is historic (Relyea, 1987).

FOIL has proved crucial for investigative journalists uncovering stories on government waste, corruption and public health matters. Despite this, researchers are yet to unlock the potential of FOIL as a tool for empirical research in the areas of social science and law (Brown, 2009). There have been uses of information requests in research (Griffiths, 2010; Murray, 2012), but this has primarily focused on other jurisdictions (Lee, 2001; Walby & Larsen, 2012). Whilst some work has examined the value of FOIL as a research method (Lee, 2005), academics interested in FOIL have often focused on potential negative impacts (Breathnach et al. 2011; Wilson, 2011), rather than looking at the positive contribution FOIL can, and has already made.

FOI requests have potential to be a robust research utility on both a theoretical and practical level. Such requests can facilitate researchers to access data that can be subjected to analysis. Theoretically, data obtained through FOI can be seen as a powerful instrument for democratising the research process. With the increasing disclosures by government, some have questioned the need for freedom of information provisions at all. However, these detractors are limited.

Lee (2005) concluded that the majority of FOI requests are not for traditional social research purposes. Recent instances of UKFOIL use have included local authority data on business cases for new schools (Khadaroo, 2008); Ministry of Defence Medical data (Seal, 2006), Department of Health data on drug addiction policy (Mold & Berridge, 2007) and Police force crime data (Hutchings et al. 2006). There has also been an upsurge in the leaking of public records data, including most notably Wikileaks which have been used to examine issues of governance and accountability. These leaks have been claimed by Wikileaks to be original source material, which opens a new line of query (Curran & Gibson, 2013).

Research access to publicly held data brings with it ethical and legal questions of confidentiality, and security. The Administrative Data Taskforce (ADT) report recommended the use of safe or secure data settings (UADRN, 2012). Safe settings include the Secure Data Service (SDS), the HM Revenue and Custom's (HMRC) Data Lab and the Ministry of Justice (MoJ) Data Lab. SDS refers to individual level data access that is more detailed standard licensing and provides potentially richer sources of evidence for social research. The user examines the information remotely instead of downloading them. The outputs are checked by the data provider. The conditions of use are based on special licensing agreements with users and user accreditation, individual training and trust. The HMRC's data lab allows access to individual tax records under controlled conditions and the Ministry of Justice (MoJ) Data Lab facilitates organisations working with offenders to have their data linked to the MoJ re-offending records. Elliot et al. (2013) in their research concerning new sources of data collection in the social sciences, found that 26 per cent of their survey respondents had used virtual safe settings to access and analyse data.

Research questions may be addressed using a plethora of data collection methods. Each process of information collection has both advantages and disadvantages, and FOI is no different. Data gathered using FOIL can have vast academic value, provided, like any other method, the researcher has an appreciation of the pros and cons of the process. By providing a way to access information produced and/or assembled by public authorities, FOIL facilitates access to data that otherwise could not be, at least without drawn-out negotiations with public authorities.

Relyea (1987) argued that academics make up a relatively small proportion of FOIA users, and this has been confirmed in recent times (Lee, 2001). Moreover, within social research FOIL appears to rarely be used as a data collection source, relative to other methods. Riedel (2000) traced the use of FOIL by researchers to obtain data for secondary analysis. His study, though a general introduction to the U.S. FOIL, made no reference to criminologists utilising this research data.

Social scientists in the United States have used FOIL, among others, in the following areas: (1) the collusion of academics with intelligence-gathering activities (Diamond, 1992); (2) the surveillance of social scientists by law enforcement agencies (Keen, 1999); and, (3) the attempt by the United States to establish economic, cultural, and political supremacy over other nations (Calavita, 1992; Coleman & Seligman, 1988) .

The reasons put forward for not utilising FOIL involved lack of awareness of the types of information obtainable through the methodology, and the procedure that was to be followed. There was a perception that to rely on FOIL would jeopardise the relationship of the researcher with the information-carrying bodies, risking future research access. Cynicism was also

prominent that institutions would actively seek loopholes around the provisions where they did not want information to be released (Yeager, 2006; Brown, 2009).

The issues that prominently feature can be addressed relatively auspiciously. The matter of lack of awareness can be elucidated through raising education and training. Universities usually offer training from a compliance perspective on the manner in which its staff should respond to FOI requests, but fail to provide any training on how academic researchers may use the method to obtain information for their projects.

The introduction of FOIL, though virtuous, did not eradicate the long-established cultures of secrecy in government and other public authorities. Research in other jurisdictions has demonstrated that there are often attempts to circumvent the new rights and to attenuate them (Roberts, 2005). It featured in the development of FOIL in Canada, where measures designed to ensure that central government could effectively 'handle' sensitive FOI requests, was put in place to reduce the damage to the reputation of the state.

An additional concern with FOIL is that public institutions may arbitrarily rely on one of the legislation's exemptions to refuse access. However, there are systems of internal reviews and appeals which have the potential to protect against such refusals.

FOI requests have the potential to deliver substantial information to assist in key areas of research. It is however, necessary to appreciate the limitations of the data that can be obtained. FOIL should be used in a manner which complements the research design, and this can only be done if the research question is appropriate. FOI requests are well-suited to procuring documentation produced or held by public bodies or data collected or held by those authorities.

Official documents and records may be a rich source of data for social research (Bryman, 2004). However, in many cases, such documents are not published, and may need to be obtained through FOI requests. Data contained in official documents may be quantitative or qualitative/text based. The usage of official documents may reduce reflexivity in research (Bryman, 2004), but may lead to sorting and interpretation problems, as the information provided is often not expressed in language that matches researchers' requirements. However, unlike unsorted and unfocused official information where the research has no control over the raw data, FOI requests allow researchers to tailor their request to the data they require. The translation and coding exercise that can accompany the use of official documents is anticipated in the content of the request, making the data more akin to primary material, obtained by targeted questions, than the pure secondary material of official documents. This distinction is key, because it contextualises FOI requests and the data obtained through the exercise of this methodology in terms that academic researchers can understand and evaluate for their purposes.

FOI requests can yield a large volume of data, particularly if the same request is submitted to multiple public authorities (Morris et al. 1981). Formulation of fit-for-purpose data management strategies are therefore crucial in the research design. FOI requests fall outside the traditional dichotomy between primary and secondary research, which is often used to identify the ethical issues that are raised by research (Walby & Luscombe, 2018). Information gained through FOIL is publicly available but is only made so in response to a request submitted by the researcher.

Blackbox Problems

There is also a collection of issues known as the black box problems. Information produced from sources such as the FOI, forms an important category of unobtrusive measures (Webb et al. 1966, 1981; Lee, 2000). From the social science perspective, usage of the FOIL as a means of collecting data has limitations common to unobtrusive measures (Webb et al. 1966, 1981). Data from interviews, questionnaires and other traditional methods tend to be generated with a particular research question in mind. Unobtrusive measures, on the other hand, depend on what is available to be found, captured, or retrieved (Lee, 2000). There is limited guidance available in the literature about the manner in which unobtrusive data, relevant to a particular research problem, can be generated (Sechrest & Phillips, 1979; Webb et al. 1981, Lee, 2001).

Archives are essentially large 'black boxes' from which a researcher is required to extract the useful data without being able to look directly inside (Calavita, 1992). Archive-based research can be likened to an archaeological dig, and where it is not possible to know in advance precisely what remnants to look for, and what lies under the surface.

Researchers have three broad choices when faced with the such issues. They can (1) get cultural knowledge of the box's inner workings; (2) rely on already codified information about the contents of the box in the form of indexes, catalogues, and finding aids; or (3) attempt to look for something already likely to be there by taking a chance.

The pros and cons of each strategy are multifaceted. The first approach is time consuming and may suffer from its own problems of access. However, publicly available data on the history, mandates, objectives, structures, and agendas associated with a particular authority can be used to identify broad administrative purposes and the information needs likely to be associated with them.

Bureaucracy has several self-preserving characteristics none of which are more important than protection of its public image (Lee et al. 2011). Inherently, bureaucrats are thus drawn to protect individual career opportunities, and their future prospects. It can thus be understood why it can be difficult to carry out independent research on questions which are controversial to

state entities. For example, officials at the U.S. Military Academy have been found to be apprehensive and defensive whenever members of the press, or academic researcher attempt to gain access that departs from the standard public relations tours, briefings, or press releases (Burgess, 2003). The Military Academy are an illustration of state bodies relentlessly persevering to prevent controversial reports from reaching the public, by denying researcher/press access by controlling access to data.

Burgess (2003) found that these tactics can include: (1) Refusal to allow access to purportedly protect the individual liberty and right to privacy of personnel. (2) Designation of sensitive security classification to controversial documents. (3) Liberal use of the quasi-classification, 'For Official Use Only'. (4) Specification of data for administrative purposes, internal to the functioning of the organisation and, therefore, not applicable under FOIL. (5) Concealment of information that is potentially available, but not readily at hand. (6) Limited access to data, making it incomplete or misleading. (7) Controlled access to data, rendering it distorted and giving the picture desired to be shown. (8) Lengthy bureaucratic delays to dissuade the seeker. (9) Harassment and sanctioning of the researcher, if he/she is within the military. (10) Stipulation of prior written approval before publication of independent research using the acquired data. (11) Discrediting the researcher if the published data is viewed as unfavourable to the military.

Blanket refusals under the facade of infringement of privacy of employees is a popular means of preventing access to military data. Burgess (2003) cited the example of archives at the West Point Library utilising this rationale for refusing access. It can be argued that while individual rights must be protected, the illegitimate pretext for protecting the institution should be resisted.

The second approach can also be time consuming if suitable material is not already in the public domain, in which case, the black box problem may manifest itself in a different manner. Having access to already available information reduces search times for it, but is most useful if the concerns and interests of its producers are relatively close to those of the researcher. Speaking of 'a level of file disorganization matched only in some people's attics,' Calavita (1992:14) found that U.S. Immigration and Naturalization Service (INS) records were 'catalogued according to a variety of overlapping and unwieldy systems', which did not relate unambiguously to the researcher's interest. Black box problems can thus discourage the opportunistic use of data, and potentially requires research skills that are underdeveloped in the social sciences (Marx, 1984).

Researchers with experience of using FOIL are convinced in the view that it is ill-advised to rely on using its provisions to acquire data one is working on tight deadlines or the project for which said data is being collected, is done so on the expectation that fit-for-the-purpose, fully

usable material will be available (Keen, 1993; Noakes, 1995; Price, 1997). There are examples of researchers waiting as much as eight months to receive FBI records relating to the American Sociological Association (Keen, 1992), and others between 1977 and 1991, exchanging more than 1,700 letters with the FBI in relation to FOIA requests (Diamond, 1992). These issues often cause researchers to seek recourse to other sources (Noakes, 1995).

These complications, leading to problematic FOI request processing can be associated with a number of organisational issues. Understaffing, underfunding, and bureaucratic disorganization are common problems across jurisdictions. Commentators note that changes in personnel or in administrative structure within agencies can significantly affect compliance with FOIL (Aid, 1998; Theoharis, 1998).

An example of the research dynamics of FOI requests can be found in Theoharis (1998) survey of historians who had used the FOIL to study the FBI. Respondents cited problems such as being unable to identify relevant material, having to pay substantial amounts in processing fees, and/or receiving massive volumes of material containing a high level of garbage data. The participants, when asked to evaluate their use of FOIL were overall positive about their experience(s). The obtained material had been vital to the successful completion of their research, and in many cases, the respondents had received material that could not have been obtained in any other way. FOIL managed to render visible previously unknown actors and actions, often in a detailed and specific manner. Records released under the provisions of the FOIA often provided shoe-ins to new areas of research and gave insights into areas previously deemed obscure. Institutionalized discovery practices can, as such provide a viable source of data for social research.

FOIL in Policing Research

Policing in the UK has undergone a process of precipitous and noteworthy transformation in recent decades, and much of it relates to the management, sharing and use of information. Despite the fictitious image regaled by the media and the public that depicts round-the-clock on patrols, gunfights, high speed highway chases, and cases solved by brilliant eccentric loners, it can be argued that policing has always been, and remains, an information handling profession (Ericson & Haggerty, 1997). The efficient management and usage of information has a crucial function in crime prevention, reduction and investigation strategies, and the volume of data that police officers encounter in the course of their work (Luen & Al-Hawamdeh, 2001). In the past, much of the operational activity of policing, and the records generated from it, were kept from public scrutiny, police forces in the UK (since 2005) operate in a climate of openness, where state bodies and the public demand transparency, performance measurement and data disclosure.

Police communication is important: democratic societies need open, responsive and accountable police forces. In the UK, an amalgamation of factors, including FOIL, has steadily strengthened a movement towards an apparent philosophy of greater openness and professionalised communication on the part of police forces. However, unrestricted transparency is far from the actuality. The reality is that police organizations, because they are heavily constrained by local politics, sensational media, and growing litigation by members of the public, feel compelled to defend every action they take, overestimate their effectiveness in fighting crime, and guard against competing points of view (Rosenbaum, 2010).

The emergence of police forces that are arguably both more dexterous as handlers of information and more open to the scrutiny of outsiders than before, can best be described as a work in progress. Gottschalk & Solli-Saether (2007) suggested that occupational culture is 'shaped by the socially relevant worlds of the occupation'. In the context of a highly deferential and hierarchical organisations such as police forces, individuals regularly encounter public confrontation and personal peril. The result is a cultural bias that favours secrecy, self-protection, violence and the closing of ranks when under threat (Chibnall 1979, Christensen & Crank, 2001).

Mawby (2002a, 2002b) noted that Sir Robert Mark can be credited with the move away from this culture of 'tell them only what you must' to one of 'withhold what you must', thus encouraging more openness between the Metropolitan Police and the news media. This policy of apparent transparency can be traced to the formulation of the premise that the press could be useful as a partner in the fight against crime, and as a means of elevating public confidence in the police as well as improving morale within the force itself (Ericson et al. 1989).

Legislation not specifically directed at police forces has made contributions towards this change. The Human Rights Act 1998 (Great Britain, 1998a), the Public Interest Disclosure Act 1998 (Great Britain, 1998b), and most significantly the Freedom of Information Act 2000 (Great Britain, 2000) all played a key role. Relevant policy schemes included the Modernising Government agenda of the Tony Blair government, which concentrated on public sector reform, including improvements in public sector accountability (Parliament, 1999). It led to an agenda of police reform delineated in the white paper, 'Building Communities, Beating Crime: A Better Police Service for the 21st Century', which attempted to build 'a more responsive police service with neighbourhood policing at its heart' and to improve the manner in which the police are held accountable (Home Office, 2004).

Under FOIL, it is a requirement that a publication scheme is made available, revealing what public authorities publish in one form or another. Police forces generate material that have a great deal in common, aided partly by the National Police Chiefs' Council, formerly the

Association of Chief Police Officers (ACPO) who coordinate the creation of publication schemes across the country (Readhead, 2004).

A decade ago, statistics suggested that police services in England and Wales fielded more than 20,000 requests a year for information under the FOIA, and that the number of requests being made increased by around 50% between 2005 and 2007 (Readhead, 2007). Of the requests received, approximately 45% emanated from the mass media (Readhead, 2007).

All 43 forces in England and Wales provide online information about freedom of information and access to their publication scheme on their individual websites, although the prominence and ease of access to this information does vary between the forces. The need to study organizational culture as a way of understanding what records are available and what is accessible for research purposes is an important lesson for researchers.

These enquires often take the form of documentary analysis, where police forces provide raw data (such as numbers, facts and figures), or content-based documents containing literature, descriptions or conclusions. The use of documents was quite effectively demonstrated in a series of studies involving a failed NASA mission.

Vaughan (1996) researched the Space Shuttle Challenger Disaster of January 1986, when the NASA Space Shuttle Challenger caught fire immediately after launch. Vaughan examined what she referred to as, the 'dark side' of organizations and attempted to use the disaster as a case study for understanding individual and organization factors that preceded and ultimately led to the decision to launch the shuttle in spite of evidence of possible problems.

A substantial report was composed by the Presidential Commission that was appointed to investigate the accident and was considered by many to be sufficient an investigation. Vaughan (1996; 2004) however examined this, and various other sources: an archive of NASA documents; other investigations of the accident; U.S. House of Representatives hearing transcripts; transcripts of 160 interviews with people involved with Challenger conducted by government investigators; risk-assessment documents that were solicited by Vaughan under the U.S. Freedom of Information Act; and numerous interviews (Vaughan, 2004).

Vaughan (2006) pointed out that examining documents such as the Presidential Commission report revealed the classification of issues that are emphasized and the manner in which the issues are framed. Atkinson & Coffey (2011) made the suggestion in correlation to the idea that documents afford a distinctive take on reality in their own right. Vaughan (2006) examined three Commission Reports: The Challenger Report; the Columbia Accident Investigation Board Report, which concerned another space shuttle disaster from February 2003; and the 9/11 Commission Report. Each report was encompassed by a dominant frame, which was

respectively: an ‘accident investigation frame’; a ‘sociological frame’; and an ‘historical/war frame’ (2006: 304). Further, the 9/11 report located causation in what was referred by the researcher as ‘regulatory failure’ (2006: 300) — a term denoting problems concerning the activities of the agencies tasked with maintaining national security. An effect of that ascription of causation was to absolve the President, and to some extent U.S. foreign policy of responsibility. Such examination of documents can generate insights into how those responsible for reporting officially on major incidents interpret the background and causation of those incidents.

Considerations for Documentary Data

As this thesis will seek data from all 43 police forces and attempt to extract information from the raw data. There will be several issues that must be taken into account. There will invariably be a large volume of unsorted data, and involve archival research based on analysis of existing sources. It can also be referred to as document analysis (Berg, 2004). The two major forms are secondary analysis and content analysis. Secondary analysis comprises of analysing the results of earlier reported research, where the researcher may reassess the methods, data, and results (Neuman & Robson, 2014). This re-examination will likely take the form of evaluating whether the original work can be analysed in a new way, or if possible, sources of error or bias in the earlier research can be found (Bryman, 2012). A caveat of secondary analysis is that the original researcher is often likely to have been selective in recording data and reporting the results. Much of the data contained in a report may comprise of the original researchers’ reconstructions or interpretations. Clerical or typographical errors or omissions may also appear in the reports.

Content analysis is a technique for making inferences by objectively and systematically identifying specified characteristics of textual data (Holsti, 1969). It can be used in two contexts (Krippendorff, 2012; Neuendorf, 2016): (1) analysis of the content of various documents as part of the research process; and, (2) provide a predetermined coding scheme and categories for tabulating the contents of documents.

Most document analysis involves secondary sources containing information originally collected for purposes other than the present research project. Secondary sources have the advantages of being ready-made and generally available (Neuman & Robson, 2014). Due to the presumption that they were generated independent of the present research project, the research plan must be customised to fit the available data. Secondary sources are generally not limited in time and space. However, there are disadvantages. Such sources may not contain all the data items required for the research project. The researcher often has no way of reconstructing the missing data and may have to speculate as to the meaning of the language used in the documents.

The strengths of using secondary sources, however, outweigh the disadvantages, and their use is widespread in criminal justice research. They are referred to as secondary, as they are not primarily developed for the study in which they are used (Becker, 1989; Stergios, 1981). The key to evaluating the reliability and validity of documentary records, as well as the general suitability of the collected data for a research project, is to understand as completely as possible how the data was originally collected. In the case of police spending records on crime scene work, and laboratory forensic science, the data would have been essential to the day-to-day running of the individual organisations. The police are one of the most austerity-affected institutions (HMIC, 2014), and financial record-keeping is thus expected to be accurate and up to date. Roles and responsibilities, as well as personnel numbers are held by human resources departments at organisations, and as these are directly related to ranks, grades, and ultimately tiered wages and salaries, the data held is also presumed to be contemporaneously recorded, and exact (Maxfield & Babbie, 2009).

RESEARCH DESIGN

Taking these factors into consideration, FOIL and documentary analysis could afford a means of extracting data for the purposes of this thesis. Traditionally, crime scene research has taken many forms, including mixed-methods approaches with semi-structured interview questions, and established job analytical techniques (Kelty et al. 2011), interviews (Julian et al. 2012; Huey, 2010). Despite the challenges of FOIL data collection methods, and the potentially large data sets that were inevitable in collecting archival, secondary data from sizable organisations, the choice was made to utilize FOIL as the primary data gathering technique. The legislation, through its provisions had several advantages, as discussed above, which facilitates researchers of any standing to access organisational information, otherwise inaccessible to the general public. FOIL also had the potential to illustrate the robustness of police information management systems and make a significant contribution to a limited body of knowledge surrounding FOI as data collection method in the social sciences. Any questions about the state of the forensic science, and crime scene investigation in the United Kingdom would require not only qualitative assessments, but quantitative information to validate those assertions. The scope of the potential study also depended on the size of the sample, and the potential participants of the research.

Research design was also driven by considerations of access, data management and practicality. Due to the nature of the work, and the organisations involved, gatekeeping and general concerns about access restrictions was at the forefront. Law enforcement organisations being large data hubs was expected to house information about their own recruitment processes as well as their human resource data and financial spending numbers. From an organisational

standpoint (a focus of this doctoral thesis), interviews or surveys would only have given a subjective output from organisational actors whose own views could have not been aligned to their respective establishments. Freedom of Information was the most effective means of gathering data, where access was not a concern, and the data collection system could be streamlined for effective sorting and management of the information sourced. As a future research endeavour, interviews, as well as surveys could be utilised in conjunction with this thesis in order to ascertain the differences or similarities between organisational expectations and the realities, as experienced by staff in these organisations.

Participant Groups and Sampling

Despite the potential size of the study, and the nature of the data collected, a decision was made to approach all 43 police forces in England and Wales, as well as Police Scotland, and Northern Ireland. In the case of the United Kingdom, therefore, no other sampling considerations were necessary.

Table 4.3 Police Forces in the United Kingdom — Participants of Research project

ENGLAND	**WALES**
Avon and Somerset Constabulary	Dyfed-Powys Police
Bedfordshire Police	Gwent Police
Cambridgeshire Constabulary	North Wales Police
Cheshire Constabulary	South Wales Police
City of London Police	
Cleveland Police	**SCOTLAND**
Cumbria Constabulary	
Derbyshire Constabulary	Police Scotland
Devon & Cornwall Police	
Dorset Police	**NORTHERN IRELAND**
Durham Constabulary	
Essex Police	Police Service of Northern Ireland
Gloucestershire Constabulary	
Greater Manchester Police	
Hampshire Constabulary	
Hertfordshire Constabulary	
Humberside Police	
Kent Police	
Lancashire Constabulary	
Leicestershire Police	
Lincolnshire Police	
Merseyside Police	
Metropolitan Police Service	
Norfolk Constabulary	
North Yorkshire Police	
Northamptonshire Police	
Northumbria Police	
Nottinghamshire Police	
South Yorkshire Police	

Staffordshire Police Suffolk Constabulary Surrey Police Sussex Police Thames Valley Police Warwickshire Police West Mercia Police West Midlands Police West Yorkshire Police Wiltshire Police	

Research Questions for FOI Requests

Budgets and spending occupy an essential management space within law enforcement organisations. In the age of austerity, where HMIC (2014) expressed grave concerns about spending cuts and their effects to the police, and the fears expressed by commentators on the closure of the Forensic Science Service in 2012 (Mansfield, 2015; Gallop & Brown, 2014) the question surrounding spending, both inside and outside the laboratory, as well as the overall financial implications of scientific support within police forces, becomes even more important.

Diane Abbott, the shadow home secretary (Labour) reacted to the HMIC (2014) by stating that it demonstrated that even though the police were doing their best, some forces were struggling to respond to shrinking resources. Some were artificially downgrading the severity of 999 calls, others were unable to carry out their core functions of crime prevention, public security and apprehending criminals. Forces were setting quotas for specialist police or failing to register organised gangs in their area, because that would require further action (Grierson, 2017).

Between 2011 and 2015 there was a reduction of 20% in the amount spent on police by the Home Office (BBC, 2015b). There are no official or academic studies that reflect or reveal the impact, if any, these cuts have had on forensic science spending. Between 2010 and 2017, the police workforce shrank by 34,000 (Grierson, 2017). The effects of these cuts on crime scene examiners is not apparent from official records, and as such the data gathered from this research endeavour holds considerable value.

Each police force has its own set of crime scene examiners undertaking a wide-range of duties and responsibilities. FOIL was the most efficient way to uncover these role definitions, by way of seeking job advertisement postings from these organisations. Job postings not only list the essential and desired characteristics that these organisations are seeking from their crime scene personnel, but the variety of roles that are advertised can carry great insight into the various sub-roles that exist within crime scene units.

Due to the potentially large data sets from the 45 police forces that were approached in the United Kingdom, the research questions were kept simple, to the point, and were all included in one FOI request per police force. The questions, as they were sent to the forces, were:

1) The number(s) of crime scene investigators/examiners/scenes of crime officers, at your organisation, by year, from 2009 to 2015.

2) The recruitment criteria used for hiring new CSEs, in advertisements and job postings by the Human Resources department of your organisation. Electronic copies of these would be ideal, but if not possible, scanned paper copies are fine as well.

3) The financial spending, specific to crime scene investigation, by year, from 2009 to 2015.

4) The financial spending, specific to laboratory work, by year, from 2009 to 2015.

5) The overall financial spending on scientific support units in your organisation from 2009 to 2015, by year.

Ethics

The importance of ethics in social research cannot be overstated (Babbie, 2013; Payne & Payne, 2004). The ethical considerations for this project was given due attention. Due to the absence of human participants, identifying information, or potentially compromising data sets, the usual matters of privacy, and security were not concerns. Freedom of Information to obtain organisational data, especially public organisations such as police, where such factors as national security are a deferment category, ethical considerations for the data were minimal, once approval from these organisations was granted.

Under UKFOIL, organisations can refuse to release information for 23 different exemption categories, classed under two broad headers: “Absolute” and “Qualified”. For example, under section 38, information which would or would be likely to endanger the physical or mental health or safety of an individual if disclosed, would not be released. Law enforcement is given the power to refuse requests, if the requested information would prejudice the prevention or detection of crime or affect the assessment or collection of any tax or duty, or which relates to regulatory and enforcement activity (s 31). Personal information of third-parties is also grounds for refusal, and strict data protection laws are upheld under section 40.

It was therefore a relatively straightforward exercise to identify and address ethical matters, as protection was being afforded from both the researcher’s end, as well as the data-holding organisation.

CONCLUSION

Social science research is important to guide policy and practice towards a fact-based status quo, rather than sensationalised fiction masquerading as fact, mostly in media portrayals of forensic science.

Even though, freedom of information legislation as a data collection method for sociological, criminological and forensic science research is in its infancy, this study was formulated with the awareness and understanding that complementary to the appropriateness of the method pertaining to the subject-matter, is the novel opportunity to examine the dynamics of FOIL as a method for social research. The evolution, current standing, advantages, disadvantages, triumphs and failures of FOIL were examined in considerable detail. Specific studies, and the FOIL in multiple jurisdictions were given attention. The types of data that such enquiries may yield were also considered.

Understanding the composition of the crime scene practitioner workforce, its size, and the costs associated with its operation, in comparison to laboratory-based investigations was found to be dependent on data held by police organisations which employ these processes, and personnel. FOIL was found to hold great potential in such enquiries, and as such 43 requests were made to police forces in England & Wales, and one each to Police Scotland, and Police Service of Northern Ireland. The next chapter will examine the outcomes of these enquiries.

CHAPTER FIVE

5.1 RESULTS

There have been questions surrounding the role of scene investigators/examiners in police organisations with emphasis on the nature and scope of their responsibilities (Harrison, 2006; Kelty, 2011; Kelty et al. 2011; Ludwig et al. 2012). The classifications of these role types, and their unique dynamics, though discussed, have not been strategically mapped. While the roles and responsibilities of these practitioners are largely understood, the source of this information also requires examination. Definitions are found in research studies where former members of forensic science units utilise their experience to construct narratives, however, few studies have used data from police organisations to demarcate the boundaries of the crime scene vocation.

UKFOIL was used to request job posting and/or advertisements from Human Resource (HR) departments of police forces in England, Wales, Northern Ireland, and Scotland. A total of 45 requests were made in 2015 for records starting from 2009, until 2015. Out of the 45 requests, 36 provided at least one (1) role profile. These profiles varied in detail and the roles that were mentioned, however, it afforded scope to detail the types of crime scene jobs that these jurisdictions employ. The financial data sought had more mixed responses, as outlined below.

There was a common disclaimer usually attached to responses from forces which had refused at least some part of the request for information. It read: "Due to the different methods of recording information across 43 forces, a specific response from one constabulary should not be seen as an indication of what information could be supplied (within cost) by another. Systems used for recording these figures are not generic, nor are the procedures used locally in capturing the data. For this reason, responses between forces may differ, and should not be used for comparative purposes."

<u>FULL REFUSALS</u>

The reasons for refusal varied. The refusals utilised the exemption under Section 12(1) of the Freedom of Information Act 2000. Full refusals, and non-responses were from just four forces in England. There was no such conduct from Wales, Scotland, or Northern Ireland, although limited data was provided from some forces.

The forces which refused, and their reasons were:

- Avon and Somerset Police refused on the grounds that, despite them holding the relevant information "the cost of compliance would exceed the cost limits under the Act which is currently set at £450 or 18 staff hours work". They further clarified that as financial data was not "centrally recorded and would involve an extensive search of [their] records to find and

collate it", also adding that "it would take considerably longer than 18 hours to retrieve the information". The first two questions, which were separate from the financial data requests were not addressed at all in the refusal letter, and no information was provided.

- Cleveland Police sent a refusal based around similar grounds, stating that "staff and research required would be way in excess of the time limit allowed under FOI". They also stated that "numerous files would require retrieving and reading manually to ascertain if they are pertinent to [the] request and is estimated that this would take in excess of the appropriate time stipulated…".
- Cumbria Constabulary did not respond to the request, and as such, were under statutory breach of their duties under the Freedom of Information Act 2000.
- Dorset Police also did not respond to the request and also breached their statutory duties.

PARTIAL INFORMATION

There were also 24 forces in England that provided partial data, as well as Scotland (where the approached organisation was only developed in 2013) and Northern Ireland, while one Force in South Wales did the same. The partial data was related to the financial information that was sought. The reasoning behind the refusals were for the following reasons:

Bedfordshire Police stated that they were unable to provide the costs broken down for crime scene work, and laboratory work, but provided the total cost for the "Scientific Services Unit" from 2009 until 2014. There was also a disclaimer for the data which has significance for the input and output of crime scene related information from police organisations. It was declared that "the numerical data [presented in this response] is an un-audited snapshot of un-published data sourced from 'live' systems and is subject to the interpretation of the original request by the individual extracting the data."

Cambridgeshire Constabulary responded to the request for role profiles for crime scene practitioners with a "No Information Held" notice. There was also useful information provided on the data management systems in use and the organisation's storage of such information. It was advised that "Scientific Support is now a collaborated unit between Cambridgeshire, Bedfordshire and Hertfordshire" and that "financial systems were also changed in 2010 and [they] are unable to provide information prior to that year".

Cheshire Police refused to provide financial information with a detailed account of their lack of inventory and record-keeping related to forensic science and crime scene work. Their refusal was based on the costs exemption under Section 12 of the Freedom of Information Act 2000, whereby if costs to retrieve the information exceeds £450, a request can be denied. They stated that "to answer [the] request [they] would need to read through every invoice to ascertain

answers to questions 3 and 4. For one year alone there would be approximately 250 invoices which would take approximately 15 minutes per invoice totalling 62.5 hours this exceeds the appropriate limit. In addition [their] Finance system only dates back to 2010 and [they] would need to go back through archived finance data which would take longer than the aforementioned. This exceeds the appropriate limit and [the] request is refused."

City of London Police also were not able to provide the financial information and refused by stating that they were "unable to supply the requested information in respect of questions 3-5. This is because the functions… are not conducted by one individual department, and it is not possible to isolate the costs according to the categories… requested."

Derbyshire Constabulary were unable to produce the information relating to the cost of crime scene investigation, by stating that no information was held. Their reasoning was that "such costs are not routinely costed and come out of the overall, allocated departmental budget." They also stated that they had attached a "Job Overview" of crime scene staff, but it was not sent with the response, and no follow up was sent either.

Gloucestershire Constabulary did not have a breakdown of laboratory work, and other financial costs associated with Scientific Support, citing "unfortunately the Constabulary is unable to split these costs between the items specified in questions 4 and 5." A consolidated response was provided which reflected the overall cost of spending on scientific support.

Greater Manchester Police were also unable to provide the breakdown of laboratory expenses, stating that they were "unable to collate this data as it is not coded separately within GMP's accounts"

Hertfordshire Constabulary could not provide a breakdown of either crime scene or laboratory expenses, instead, providing the budget books from 2010 until 2015. The expenses were labelled as "B, C&H Scientific Services Unit" for each of the years. There was no explanation provided as to why there was no breakdown. Question 2, which concerned the recruitment criteria for CSEs yielded a useful response, despite no role profiles being provided. The response read: "Following enquiries within the Constabulary's HR Department… the criteria the Force use[s] is that the applicants would have evidence against the following in no more than 500 words per sections. (1) Service Delivery; (2) Professionalism; (3) Decision Making; [and] Working with others." No explanations or examples of these headers were however given in the response.

Humberside Police refused to provide any financial information citing Section 21 of the Freedom of Information Act 2000 as their grounds for refusal. It was specifically stated that "as section 21 is an absolute exemption there is no requirement for [the Force] to conduct a public

interest test." A link to an HMIC report titled "HMIC Value for Money Profile 2014 — Humberside Police compared with all forces in England & Wales" was provided in the response, which proved somewhat useful, but did not fulfil the request. There was however, an extremely valuable assertion in the response relating to crime scene practitioners, and their work in the lab. It was stated that, "The CSIs would previously have carried out basic DNA recovery of seized property, but new regulations dictate that this must now be carried out in a UKAS 17025 accredited facility, so the answer would be £0 if this is specifically relating to CSIs. However, if reference is being made to out-sourced forensics (with FSPs), then we would only data going back to July 2013 when we regionalised. CSI/Scientific Support was regionalised across the Yorkshire and Humber in 2013."

Lancashire Constabulary were unable to provide a breakdown of laboratory services by stating that "the amount spent specifically on laboratory work is not recorded as a separate figure by the Constabulary; the costs for laboratory work are within the "SSD Total" figures given…" They however provided total figures relating to the expenses as a whole under Scientific Support Department (SSD).

Leicestershire Police provided important information through their inability to supply role profiles or recruitment criteria for crime scene staff by stating that they "have not recruited into the post for the last 5 years and as a result we do not have an up to date recruitment criteria." No breakdowns were provided for crime scene and/or laboratory expenses citing that the Finance Department could not break down the figures any further. The financial data, which was not labelled, was not provided for 2009 and 2010 either.

Lincolnshire Police could not provide total cost of scientific support, by stating that there was no label within the Force for scientific support, under costs. They however were able to provide information relating to 'imaging & high-tech crime unit', 'regional forensics', 'fast track DNA' and 'forensic cost centre'. The most illuminating information that came from the request related to the data management systems within police forces in the United Kingdom. A note in bold letters was attached to the FOI response, which read: "Please note that Police Forces in the United Kingdom are routinely required to provide crime statistics to government bodies and the recording criteria is set nationally. However, the systems used for recording these figures are not generic, nor are the procedures used locally in capturing the crime data."

Metropolitan Police were delayed in their reply, and they officially sought an extension to the time allocated for response. The Force provided "full disclosure" as per their own wording but were unable to provide the financial data requested in the format requested. There were issues specifically surrounding laboratory costs, or total expenditure for scientific services could not be isolated. The following reasoning was given for both: "MPS Forensic Services cost centre

structure does not allow costs specific laboratory work costs to be isolated, as such costs below relate to the Science Function with the command, and separately, costs relating to External Forensics Providers."

Northamptonshire Police provided partial data on the number of crime scene staff but were consistent in their presentation of data from 2011 until 2015 both as headcount figures and full-time equivalent (FTE). They did not provide any recruitment data or role profiles for crime scene workers, instead referring to Multi Force Shared Service (MFSS) with which they said they were involved. For breakdowns of financial figures, they explained that their "accounts are not split down into the categories asked for" and that they were "not able to break it down any further". The expenses were categorised under the Protective Services Command (2009/10), Crime & Justice – Major Crime (2010/11), Crime & Justice – Crime Support (2011-2013), Crime & Justice – Investigation Department (2013/14) and Operational Collaboration - Regional Collaboration (2014/15), and were broken down into the following over the requested period, although not repeating every year: (1) scientific support command; (2) forensic investigation; (3) forensic services – livescan; forensic investigation – vehicles; forensic/DNA processing costs; DNA expansion programme – staff; fingerprint services – livescan; and forensic/DNA staff. It was attached with a note that clarified that autopsies were included until March 2014 and costs such as Police Pay, Estates and Facilities, Stationery, Printing, Office Equipment and Transport were centralised under Forensic Investigation, including Police Staff, equipment and operational costs.

Northumbria Police's response contained crime scene personnel numbers as FTE figures after "searches were conducted with the HR and Finance Departments". They also provided six different documents containing role profiles (the most given by any single Force). However, for the financial information sought, all three questions were answered with a 'No information held' response. It was stated that the Force does not hold information on the figures spent on crime scene work, laboratory expenses, or the total costs incurred on scientific support during the period sought (2009-2015).

Nottinghamshire Police did not provide data by year for crime scene personnel but stated that at the time the FOI response was sent (17 December 2015), the number was "29.1 FTE or 30 people in the role of Crime Scene Investigator, Volume Crime Scene Investigator or Crime Scene Investigator Manager". One role profile was included, with a link to the Nottinghamshire Police website. The linked page, titled 'What is a Crime Scene Investigator?' provided a descriptive account of crime scene investigators in the jurisdiction (Nottinghamshire Police, n.d.). Data for the financial spending specific to crime scene work was provided, which included "pay and non-pay items". However, laboratory spending was not attached. The reason

given was that the Force did not "have a specific costing code for laboratory work. In this instance costings are not coded individually on invoices by type of work but are under one costing code for the CSI Department." There was also no data afforded for the request for financial spending specific to scientific support. The rationale given was that "within Nottinghamshire the Scientific Support Units are included within the CSI Department."

South Yorkshire Police's response began with a statement that "West Yorkshire Police is the Lead Force for the Region" and that they will "hold further information". The information provided with the assistance of the Regional Area Forensic Manager. Crime Scene personnel numbers were provided for each year. However, the financial information was not given. It was stated that the information could be retrieved by contacting West Yorkshire Police for the crime scene expenses and overall scientific support spending questions. There was an explanation attached for the query relating to laboratory expenses, which read: "The CSIs would previously have carried out basic DNA recovery of seized property but new regulations dictate that this must now be carried out in a UKAS 17025 accredited facility, so the answer would be £0 if this is specifically relating to CSIs. To get this answer for previous years would fall into the 'too difficult to quantify' category really' [certainly over the 18 hours of work permitted under FOI legislation]".

Staffordshire Police's response had three digital files, including the official response letter which were corrupted and could not be read. There was a follow-up email sent for copies of these files, but there was no response. The Force did however provide one role profile, and the figures for the number of crime scene staff. As the response letter was unavailable, no impressions, reasoning or explanatory information could be retrieved for presentation or analysis.

Surrey Police did not provide data for any question other than crime scene personnel numbers and did not attach any role profiles. They did however include gross budgets, and the expected spending for crime scene work and external lab work for the years 2013/14 and 2014/15 — although, this information was not requested, as actual spent numbers were sought rather than budgets. It was stated that they could not "satisfactorily split out the budget further as internal lab costs would come under other payroll costs". The Force did however add that should further clarification be needed for the budgeting, "Surrey Police [should be contacted] on 101 and ask[ed] to speak to the Management Accounting Team who provided the information to us for… [the] FOI request".

Warwickshire Police made available crime scene personnel numbers with the disclaimer that "this information [was] not held in a readily retrievable format as roles that may have crime scene investigation/examination duties may not always have been titled crime scene

investigators /examiners / scenes of crime officers. Information provided below [was] retrieved for those roles that do have `Crime Scene` in their duty title". As a result, for the time between 2009-2011, the figures were shown as zero. One role profile was provided. No statutory provision was cited or availed for the refusal of the financial information sought. It was explained that "this information is not held in a readily retrievable format. Financial spending specific to crime scene investigation and laboratory work is not held centrally or in an electronically searchable format as it covers different areas of work within different departments".

West Mercia Police provided a carbon copy of the Warwickshire Police response, as they are collaborative Forces. The only difference was in the letterhead used.

5.2 CRIME SCENE PRACTITIONERS: ROLES AND RESPONSIBILITIES

Using the collected data, this section examines the state of crime scene work and its practitioners within the broader context of law enforcement, and the criminal justice system. The roles and responsibilities of crime scene practitioners has been a concern for sociologists for over two decades (Williams, 2004; 2008; Williams & Weetman, 2012; Julian et al. 2012). There have been studies to examine the perception of crime scene staff by other members of the criminal justice system, as well as themselves (Ludwig et al. 2012). Studies have also attempted to formulate the characteristics of top-performing scene examiners (Kelty et al. 2012), as well as suggest a route to professionalization of the discipline (Robertson et al. 2014). For years, commentators have suggested contrasting roles and responsibilities of crime scene practitioners, especially about their place in the law enforcement infrastructure (Williams, 2004).

Researchers often explored the suggestion that crime scene work could be scientific (Nordby, 2012), and by extension scene practitioners, scientists (Harrison, 2006). There is however deep divide in both camps. Arguments either way, can only be sustained if the roles and responsibilities of crime scene practitioners is well-documented, as well as the organizational expectations of the job. There is little research about the difference between crime scene investigators, crime scene examiners, scenes of crime officers (SOCO), and other designations assigned to scene workers in the field. The terms are used sparingly, and in a manner often suggesting that the roles could be one and the same. Studies have also attempted to draw a distinction by declaring crime scene examiners to be merely those who examine a scene, while investigators go further. Such classifications and only confusion to an already unclear subject matter, and as such further investigation is warranted.

Studies have also elucidated on the purported marginalization of crime scene practitioners as merely technical assistants; whose only responsibility is to bag and tag the evidence (Wilson-Kovacs, 2014; Wyatt, 2014). Practitioner texts on the subject, as well as textbooks on crime scene work suggest a different function of scene workers, where the role is wider in scope and their contribution to criminal investigations more potent than conventional commentary. It is therefore another area which requires additional scrutiny, through empirical research, rather than perception data collected through qualitative methods such as interviews and surveys.

Question and Response Rate

The data for the project was derived from freedom of information responses sent to all 43 police forces in England and Wales, as well as Scotland (1) and Northern Ireland (1). It made the following enquiry: “The recruitment criteria used for hiring new CSEs, in advertisements and job postings by the Human Resources department of your organisation.” The question

(along with four others) was sent out by email to the respective forces, under the provisions of the UKFOIL. A total of 29 police forces responded from England, along with Scotland (1), Northern Ireland (1), and all four (4) forces from Wales (77.7%). The combined tally of role profiles was 59, which were separated by the types of roles that the documents advertised or described. These included a wide number of roles and responsibilities, including Crime Scene Investigator (CSI), Crime Scene Examiner (CSE), Scenes of Crime Officer (SOCO), Vehicle Examiner/Investigator, Scientific Support Officer (SSO), including other lesser known designations.

Table 5a

ROLE PROFILES					
	ENGLAND				
No.	**Name**	**CSI**	**CSE**	**SOCO**	**Other**
1	Bedfordshire Police				1
2	Cheshire Constabulary	1			
3	City of London Police		1		
4	Devon & Cornwall Police			1	
5	Durham Constabulary	1			
6	Essex Police	1			
7	Gloucestershire Constabulary			1	
8	Greater Manchester Police	1			
9	Hampshire Constabulary	1			
10	Hertfordshire Constabulary				
11	Humberside Police	2			1
12	Kent Police	1			
13	Lancashire Constabulary	1			
14	Lincolnshire Police	1			
15	Merseyside Police	1			
16	Norfolk Constabulary	3			1
17	North Yorkshire Police				1
18	Northumbria Police				4
19	Nottinghamshire Police	1			
20	South Yorkshire Police	3			1
21	Staffordshire Police				2
22	Suffolk Constabulary	3			1
23	Sussex Police	2			
24	Thames Valley Police	1			
25	Warwickshire Police			1	
26	West Mercia Police			1	
27	West Midlands Police				1
28	West Yorkshire Police	1			1
29	Wiltshire Police	1			
	SCOTLAND				
30	Police Scotland		2		
	NORTHERN IRELAND				
31	Police Service of Northern Ireland	1			5
	WALES				
32	Dyfed-Powys Police	1			
33	Gwent Police	1			
34	North Wales Police	3			
35	South Wales Police	1			

	TOTAL	33	3	4	19
	Total No. of Profiles	59			

Sample Size

There was a total of 59 role profiles submitted by 35 individual, or collaborative forces from England (29), Wales (4), Northern Ireland (1) and Scotland (1). The number of role profiles from individual jurisdictions varied with England (45), Wales (6), Northern Ireland (6) and Scotland (2).

Format and Labelling

Profiles were sent via e-mail in Microsoft Word, or PDF format. They varied in formatting, with some preferring tables, while others listed requirements in plain text. They were also drafted in a variety of ways, which indicated that there was no set format for advertisements or any centralised format that forces were following. While the usage of different naming schemes for the various sections in the profiles did not make said profiles undecipherable, for example, Nottinghamshire Police's label of 'Principal Accountabilities', South Yorkshire Police stating 'Main Duties', or Wiltshire Police simply including everything under a common 'Description' header did not prevent the reader from understanding their purpose of laying out the main/principal responsibilities of the applicant/recruit, but did demonstrate a lack of uniformity.

South Yorkshire Police stated expressly in the role profiles that "for recruitment purposes the summary of main duties should not exceed 12 bullet points", while Greater Manchester Police (38), Devon & Cornwall Police (17), Hampshire Police (12) all included more. Salaries were mentioned in some, while not in others. No explanation or elaboration was afforded for the salary bands (grades) with individual forces preferring a wide range of labels, including Essex Police (Scale 4/PO1), Greater Manchester Police (Grade E), Hampshire Constabulary (SO1/Constable Grade), and Lancashire (LC 6-7) being examples of differences.

Types of Role Profiles

The forces provided a wide range of profiles, with Crime Scene Investigator (33), Scenes of Crime Officer (4) and Crime Scene Examiner (3) being most pertinent to this study. There were also role profiles provided for the following roles:

Forensic Science Investigator, Forensic Operation Manager, Child Sex Exploitation Officer, Hi-tech Forensic Crime Investigator, Scientific Support Supervisor, Forensic Recovery Technician, Scientific Support Officer, Scientific Support Vehicle Examiner, Forensic Authorisation Manager, Assistant Fingerprint Officer, and District Forensic Manager.

These were listed in the ‘Other’ category.

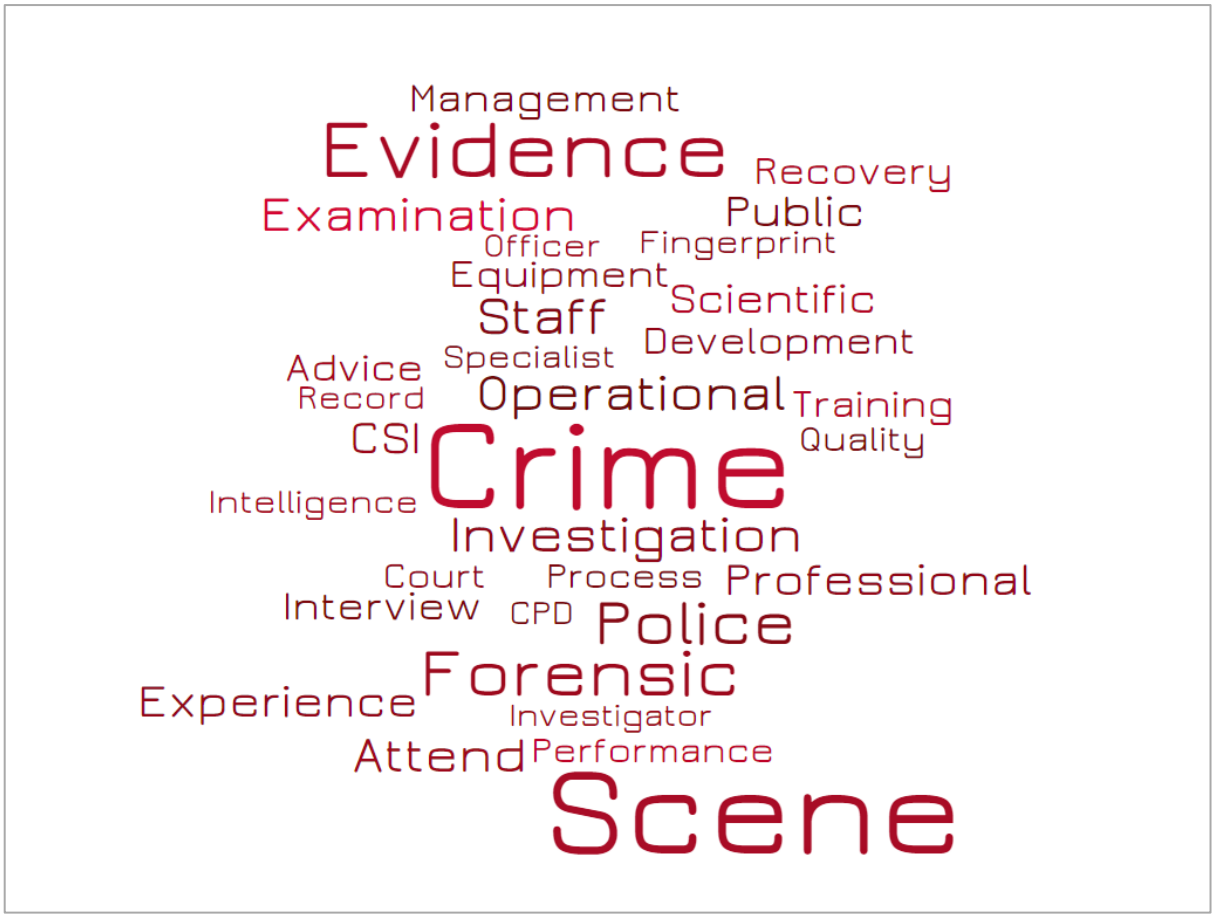
Linguistic Elements

The most repeated words in the relevant role profiles were ascertained using a simple macro-based code which counted each word and produced a list of the same with the number of occurrences. Unsurprisingly, the top words were “and” (426) and “the” (315) with “to” (289), “of” (255), “in” (132) and “a” (101) following suit. As such, these and other pronouns, prepositions, and conjunctions were ignored. Relevant, non-generic words repeating on at least eight instances were labelled and listed.

Table 5b

Words	**Frequency**
Crime	96
Scene	92
Evidence	55
Forensic	42
Police	37
Staff	28
Operational	25
Investigation	25
Examination	23
Attend	23
Professional	22
CSI	21
Experience	21
Public	20
Scientific	17
Management	16
Interview	15
Advice	14
Equipment	14
Development	14
Recovery	13
Training	13
Court	12
Performance	12
Quality	11
Process	11
Record	10
CPD	10
Fingerprint	10
Specialist	9
Intelligence	9
Officer	9
Investigator	8

A data-cloud was generated for a visual representation of these findings.



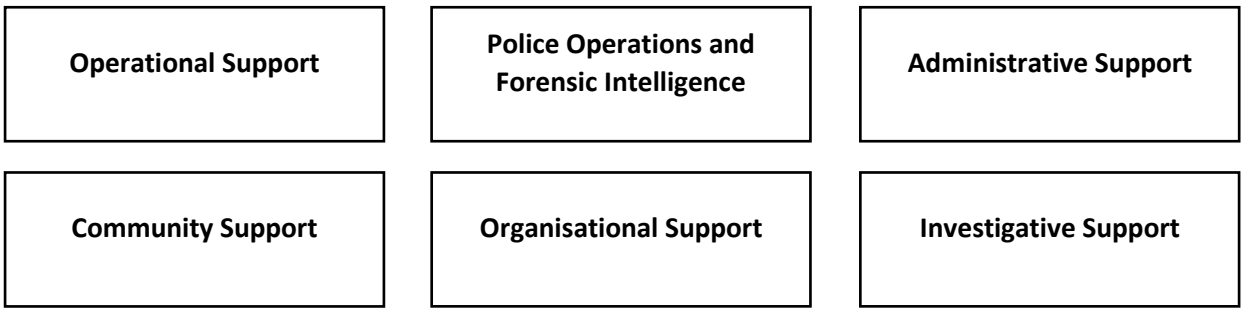
Based on the analysis to follow, the representation above does not skew from the basic facets of the crime scene practitioner role descriptions and specifications in the 59 profiles under examination. This is one of the more useful elements of word-cloud-based visual representations of data. It provides an easy-to-refer list of common terms. Most forensic science and crime scene practice research, manuals and texts have some variation, but cover almost every aspect of the words found in the above data-cloud. However, elaborations and the real-world significance of these aspects of scene work requires further examination.

Key Findings

Out of the 59 Role Profiles, 33 were for the label Crime Scene Investigator (CSI), four for Scenes of Crime Officer (SOCO), three for Crime Scene Examiner (CSE), and 19 were for other roles in a forensic capacity which were not directly connected to crime scene tasks.

Role profiles from all three classifications produced large quantities of repeating data (which was labelled and collated), as the roles, even though thought to be different (as per previous studies), were actually similar to the point that no real discernible difference could be identified. All three roles had aspects of the following in their profiles:

Main Functions of Crime Scene Practice



Operational Support

- Attend, assess, examine, retrieve, recover and package (label, seal) evidential artefacts (such as fingerprints, DNA, traces, impressions, implements) from crime scenes in accordance with Force policy, quality assurance standards (ISO 9002, 17020/17025 etc.), and internal protocols (Standard Operating Procedures etc.), after conducting appropriate risk assessments.
- Plan and carry out trace evidence recovery from post-mortems, by working closely with pathologists and forensic scientists.
- Liaise with forensic scientists either at the scene or in the laboratory and obtain further materials if/as directed.
- Capture, record, process and print evidential photographs/image data through planning and coordination.
- Perform specialist technical or manual tasks in accordance with professional, occupational and/or organisational standards, and assist with identification of modifications of methods and the development and validation of new methods.
- Instigate case assessments and plan examination strategies, forensic examinations and maintain equipment.
- Conduct examinations of evidential artefacts by ensuring integrity and continuity through correct handling, storage and documentation of evidence to support investigations.
- Evaluate and interpret investigative results and provide unbiased, accurate advice based on established principles and draft reports of findings.
- Adhere to strict health and safety codes, as well as legal and organisational requirements in all facets of work.
- Preserve the integrity of lost or seized property, by handling appropriately, and where required, dispose of unclaimed, forfeited, or seized property in line with Force policy.
- Prepare and drive vehicles safely with consideration for others in accordance with organisational policy and in line with the system of car control.

- Undertake continuing professional development (CPD) courses, participate in training programmes, and maintain extensive knowledge of scene work and scientific support.
- Attend court and present evidence with statements, documentation and other representations, in accordance with legislation.

Police Operations & Forensic Intelligence

- Participate in police and agency-led operations, working within appropriate authority limits and carrying out tasks necessary for the successful implementation of the operation, while managing risks to the operation and acting in accordance with legislation and procedure.
- Identify, assess and harvest intelligence to support policing objectives
- Gather intelligence to facilitate the achievement of crime and disorder reduction objectives.
- Promote close liaison with uniformed and CID officers, in order to facilitate the exchange of information and to assist such officers where necessary on preservation of evidence.
- Ensure intelligence is obtained ethically and in accordance with the relevant legislation, policy, protocols and codes of practice.
- Record and disseminate forensic intelligence gathered in the course of an investigation.
- Ensure that investigating officers are made aware, at the earliest opportunity, of the forensic potential of a crime scene in cases where this is likely to have a significant impact on the course of the investigation.

Administrative Support

- Input, retrieve, present and disseminate data using appropriate computer system(s), in accordance with legislative requirements and Force policy.
- Maintaining statements, schedules and incident logs of the investigation for internal records, and presentation in court.
- Maintain an up-to-date diary of events and ensure that sufficient preparation is completed prior to attendance at events.
- Participate in internal and external audits as required.

Community Support

- Provide specialist crime reduction advice to members of the public.
- Represent the police organisation by providing relevant independent crime prevention advice, in accordance with best practice and in order to contribute to the reduction of crime and disorder.
- Demonstrate support for victims and witnesses and recognising any possible impact on the community in the course of an investigation.

- Provide appropriate cleaning advice to victims of crime or their representatives.
- Provide advice and reassurance to victims of crime or their representatives in areas where they may be lacking knowledge or need support.

Investigative Support

- Conduct the initial investigation and ensure scene preservation in accordance with the relevant investigation policies and legal requirements.
- Conduct effective routine interviews for a variety of purposes; preparing, and carefully planning interviews with a clear understanding of its purpose; asking relevant questions and obtaining the required information; and, reviewing personal interview performance regularly and adapting style to suit the needs of the interview.
- Evaluate intelligence and evidence, identify and pursue (multiple, if required) lines of enquiry as required to progress the investigation.

Organisational Support

- Provide specialist advice and knowledge to staff, partners, individuals and agencies to support the achievement of Force objectives and enable compliance with Force policy.
- Provide and promote service to customers in a professional manner in line with organisational policy and legislative requirements.
- Provide advice, guidance, and feedback, to build confidence and improve effectiveness within existing roles and to acquire the knowledge and skills necessary for personal development.
- Plan and deliver training as and when delegated by Technical Management.

Characteristics & Qualifications

In order to further the above tasks as part of crime scene practitioner responsibilities, applicants were sought from various educational backgrounds and experience levels. There was no uniformity between forces in terms of the Grade or Level of the position, and the qualifications or experience required for employment. The common requirement across all profiles was that the applicant have a full UK driving license.

For example, for a SOCO Grade 4/5/6 position at an English Force, there were no academic qualifications sought. Under qualifications and experience, the profile stated: “No previous knowledge of the theory or practice of fingerprint work or forensic science is necessary, although this is desirable. Candidates must be in possession of a current United Kingdom driving licence, which they will be required to produce at interview.” Instead, the experience and qualifications sought for the role included a requirement of good standard of written and verbal communication for correspondence and reports, to be able to speak to people face-to-face, over the phone clearly and concisely. Experience of working with the public and dealing

with people was also listed. There was also a requirement for good team working skills, typing skills (written and keyboard skills), and ability to self-motivate, to work under pressure and to prioritize and meet deadlines.

Another force provided the role profile for a SOCO, which had the requirement of completion of modules 1 and 2 training, and module 2 portfolio of the National Crime Scene Investigation course. It was also stated that "demonstratable experience of a scenes of crime officer" was a necessity, although it was not elaborated on further.

Two collaborative forces in England supplied role profile for a SOCO Grade E, where the requirement was cited as a GCSE grade C or above in a laboratory science, Maths and English or equivalent; in addition to an ACPO recognised CSI course. There was also a listed requirement for “knowledge of how science and technology support and aid crime investigation and an understanding of how those techniques are applied in order to obtain best evidence”.

For the Crime Scene Investigator (CSI) role, an English force provided similar qualification requirements. It listed: (1) successful completion of Initial Scenes of Crime Course OR have a minimum 'A' Level or equivalent in a science subject e.g. Biology, Physics, Chemistry OR HNC or above in Photography; (2) previous experience as a Crime Scene Investigator or demonstrate a professional photographic or scientific background (e.g. Laboratory Assistant, Photographic Technician etc); and for progression to scale 6, (3) possess the National Diploma in Scientific Support Skills and be accredited by the Council for the Registration of Forensic Practitioners (now defunct), and, typically a minimum of 3 years crime scene experience.

An important insight was found from one English force, which also required its Crime Scene Investigators to work as Constables or OCF Level 3, in addition to CSI SO1 (the entry level). The educational requirements for the role was listed as having successfully completed the NTC (Centrex) Initial Crime Scene Investigator Course, Vehicle Crime Scene Investigator (VCSI) or the VCSI Conversion course. The Home Office approved substantial level CSI courses such as the Metropolitan Police Crime Scene Examiners Level 2 Sexual Assault and Robbery course, was mentioned as an alternative. The desirable characteristics for the role were outlined as "further academic or vocational qualification that are relevant to the post", while the Essential qualities section mentioned previous work experience in a related field, such as forensic work, general science/laboratory work, and or extensive, detailed investigative work.

There were also a number of functions mentioned by a large number of forces with some variation, that were intrinsic to the scene-related roles. The functions mentioned included, manual handling, working at heights, in confined spaces, at night, working with chemicals/biological hazards and disturbing evidence, observation of disturbing circumstances,

in environments with potential for conflict, violence etc. and prolonged wearing of personal protective equipment.

There are a number of role-specific training and continuing professional development courses that were required to be undertaken. These included the appropriate internal and external scientific examination courses (not specifically mentioned by some), OIS and CIS (if appropriate), GRS, H&S induction, and the SOCRATES Forensic Management System.

There were a number of behavioural competencies which were recurring in most force literature. Essential experience and specialist skills and knowledge were listed which were similar to most other forces, and included:

• Demonstrable understanding of the methodologies involved in the forensic examination of crime scenes.

• Proven experience of working in conjunction with other areas and departments involved in forensic intelligence and evidence gathering.

• An ability to evidence substantial skill in the crime scene examination environment

• Able to prove a significant practical knowledge and experience of serious and major crime.

• Demonstrably flexible approach to working hours and location in order to respond to the needs of crime investigations

However, there was no uniformity or consistency in educational, vocational or experience requirements for recruitment into any of the roles, and as Grading is done in a variety of denotations, it was difficult to ascertain the correlation between rank and qualifications sought. The role profiles also pendulum between 'no experience' necessary to seeking extensive training and courses as a starting requirement. The implications of which, are discussed later.

Key Observations

Integration into Police Organisation

There was a general trend in profiles for all three role types to promote collaboration and cooperation between members of the scene work unit, and police staff within the organisation and beyond. These were especially evident in descriptions of duties which focused on intelligence-sharing and information exchange during the course of investigations.

All role profiles from English police forces included some variation of a common 'Personal Qualities' section which was a breakdown of organisational goals and what members of the crime scene team were expected to abide by in their roles. These were not strictly scientific support unit values or specific to crime scene work, but more in line with police/law

enforcement organisation recruitment literature prompting the idea that scene staff were no longer to be thought as, at least on paper, as civilian contractors who were separate/outside of the police service.

Leadership - being open to change, positive about change, adapting rapidly to different methods of working and making an effort into getting them to work, as well as being flexible and open to alternative approaches to solving problems. Finding better, cost-effective ways to work, making suggestions for change and putting forward ideas for improvement, by taking an initiative and creative approach to solving problems.

There was another aspect of leadership that was often listed, under a separate header titled service *Delivery*. This included such abilities as understanding the organization's objectives and priorities and how the work undertaken fit into these; planning and organizing tasks effectively, while taking a structured and methodical approach to achieving outcomes; managing multiple tasks effectively by making about 'things' in advance, prioritizing and managing time 'well'; and, focusing on the outcomes to be achieved, but in quickly and accurately and seeking guidance when appropriate.

Decision-making - an ability to gather, verify and assess appropriate and available information to gain accurate understanding of situations. The capacity to consider a range of possible options before making clear, timely, justifiable decisions. Being able to review decisions considering new information and changing circumstances. Balancing risks, costs and benefits and considering the wider impact of decisions, as well as exercise discretion in applying professional judgment to ensure that actions and decisions of proportionate and in the public interest.

Professionalism - acting with integrity, in accordance with the values and ethical standards of the Police Service; taking ownership full resolving problems, demonstrating courage and resilience in dealing with difficult and potentially volatile situations, acting on own initiative to address issues, showing strong work ethic and demonstrating extra effort when the client, upholding professional standards, acting honestly and ethically, challenge unprofessional conduct or discriminatory behaviour, asking for and acting on feedback, learning from experience in developing professional skills and knowledge, while remaining calm and professional on the pressure, and defusing conflict and being prepared to step forward to take control when needed.

Public Service - demonstrating all real belief in public service, focusing on what matters most to the public and serve their interests, understanding the expectations, changing needs and concerns of different communities and striving to address them, while building public confidence by speaking to people in local communities to explore their viewpoints and break

down barriers between them and the police. There was also a requirement to understand the impact and benefits of policing for different communities and identifying the best manner to deliver services to them, by working in partnership with other agencies to deliver the best possible overall service to the public.

Working with others - cooperatively working with others to 'get things done', willingly giving help and support colleagues, and being approachable, while developing positive working relationships. The header also included requirements for candidates to be able to explain things well, focus on the key points and talking to people using language that they understand. Listening skills were also mentioned, where applicants had to have the ability to listen carefully and ask questions to clarify understanding, express own views positively and constructively, persuade people by stressing the benefits of a particular approach, keeping them informed of progress in managing their expectations, being courteous, and considerate, and showing empathy and compassion. Dealing with people as individuals and addressing their specific needs and concerns, was also mentioned. Lastly, it was said that treating people with respect and dignity, dealing with them fairly and without prejudice regardless of their background or circumstances, was desirable.

These organisational requisites represent an approach to integrate scene practitioners to the wider law enforcement structure. They are advertised in the role profiles as 'core values' or 'essential personal qualities' which highlight their importance.

Community Engagement

Commentators seldom highlight the key role crime scene practitioners play in the community, not just as evidence processors, but as sources of information on crime awareness and reduction. It was accentuated by one of the larger English forces expressly stating that a CSI was always required to take a 'victim-focused' approach. They are also, as evidenced by the continued focus by police recruiters, expected to be support systems for victims of crime, and their representatives. The role profiles emphasized heavily that scene practitioners are expected to provide advice on routine crime scene clean-up, awareness of crime patterns and preventative actions, and be supportive. This aspect can have an important bridging role between law enforcement and the citizen, as it gives one-to-one opportunity for victims of crime to give and receive information to a receptive and informed source.

Composition

The SOCO job position had only four role profiles, and Crime Scene Examiner had three. Most forces indicated in their responses that their search for records was conducted by combing through hiring documents, advertisements or in as a whole 'role profiles' which had the words

‘crime scene’ in the text. Despite a wide-variety, and large dataset, the two positions accounted for only 11.9% of the responses, with Crime Scene Investigator (56%) and other role profiles (32.1%) making up the rest.

Citation of Defunct Organisations

Several forces provided role profiles with mentions of now-defunct organisations such as the Forensic Science Service (FSS) and Council for the Registration of Forensic Practitioners (CRFP). This showed that role profiles had not been updated in quite some time, even though the requests for information was filed in late 2015, and most responses arrived in the second quarter of 2016. This demonstrated a requirement for updating old profiles (SOCO, and CSI), and was also indicative of the record-keeping issues at some English forces. This can be offset by the fact that in FOI responses some forces specifically mentioned that new staff had not been hired for many years, and as such the profiles would not have been in use either. The implication being that updating records was a more reactive exercise for some forces, than proactive.

Discussion

Throughout the past two decades there have been attempts to examine crime scene work as an independent field of study, rather than an incidental subset of forensic science (Fraser, 2000; Millen, 2000; Jamieson, 2004; Harrison, 2006; Crispino, 2008). These pursuits have demonstrated a largely bipartite division between crime scene practitioners, who are largely police-employed, evidence-collecting attendants at crime scenes, and forensic scientists who primarily undertake evidence analysis and interpretation inside laboratories (Wyatt, 2014).

The crime scene practitioners’ occupational segmentation has seen variable levels of change around the world since the last three decades. Developments in policing have historically been derived from empirical studies focusing on street officers undertaking their daily responsibilities. Researchers have observed and recorded the discretion that these officers possess. It provides a unique perspective on their duties and the limits of their professional activities. Each situation is unique, and the officers are tasked with an infinite variety of choices on how to respond to it. The resolution of any particular situation depends on the ability to appreciate its significance and the decision to that is taken out of the many conceivable possibilities. Close examination of these factors illustrate that such work is much more than strict procedures commanded by hierarchies, or the systematic application of the law. And, this approach has also been adopted to understand the inner workings of scientific support work and the integration of forensic science for criminal justice purposes.

In the United Kingdom (UK), this can be attributed to a broader process of scientification of police work (Ericson and Shearing, 1986), and the rationalisation of scientific provision (Tilley & Townsley, 2009; Williams and Johnson, 2008). Crime scene practice has evolved considerably since the days when fingerprint identification and scene work was undertaken by detective officers, with no specific personnel or department for such responsibilities (Wilson-Kovacs, 2014). In the late 1960s, the Home Office determined that investigative support through officers specialised in fingerprinting, forensics and photographic work was the way forward (Green, 2007). Two decades later, Touche Ross (1987) reviewed the subsequent changes, which comprised of the fingerprint bureau, crime scene departments and externally procured forensic services. As part of recommendations, the review stated that in order to ensure the cost-effectiveness of scientific support [a recurring theme in the history of UK forensic science], police forces should pursue the civilianisation of crime scene practitioners [determined to be cheaper than sworn police officers doing the same work] and the development and implementation of a hierarchical infrastructure of oversight within scientific support units (SSUs) at each force.

The Home Office instigated multiple studies throughout the 1990s and early 2000s in an attempt to analyse the multifaceted aspects of scientific support, with the goal to fine tune performance issues and meet the needs of modern-day policing (ACPO, 1996; McCulloch, 1996; Tilley and Ford, 1996; McCulloch & Tilley, 2000; Blakey, 2000; HMIC, 2002). In the attempt to intensify state commitment to forensic science and its provisions, performance monitoring became somewhat of a priority for the Home Office. Since the mid-1990s, it was clear that there was a significantly low level of awareness amongst police officers of forensic science provisions and techniques, poor communication and the need to assess the effectiveness of scientific support in turning identifications into timely detections (Green, 2007). This applies to volume crime where forensic case data has remained poorly integrated in crime analysis and the investigative process (Ribaux et al. 2010a; Williams & Johnson, 2008).

The occupational restructuring of in-house forensic support in official documents previously showed a pattern of using timeliness, productivity and effectiveness as standards by which crime scene practitioners are valued and assessed (Ludwig et al. 2012). Human resources (HR) literature reflects the preoccupation with standardised, quantifiable performance expectations, which often regard accountability and performance indicators as key features of professionalism (Evetts, 2013). However, there is scant knowledge on the expectations of HR departments in the police, specific to crime scene personnel.

This chapter has endeavoured to add to this literature with a large dataset to examine the expectations of police organisations for crime scene practitioners, and the boundaries of the

discipline. In the past three decades, research on the institutional dimension of science has shown the importance of collaboration (Weingart, 1982; Etzkowitz, 2004). Studies on policies and the role of academic research in company dynamics identified a new normative structure of science incorporating ideas of commercialisation of scientific knowledge. This aspect is no different for crime scene work, and it was illustrated in every facet of scene practice, especially in the Police Operations & Investigation, and Organisational Support duty classifications (above). End-users of scientific support within criminal justice contexts were continuously referred to as 'clients' in role profiles from all four jurisdictions, with stresses on cost-effective, timely service, which are phrases native to the corporate world.

In the line of duty, crime scene practitioners will encounter unique challenges which they are expected to overcome dexterously and expeditiously (Wilson-Kovacs, 2014) as each scene is different (Inman & Rudin, 2000). One of the most problematic areas for crime scene workers is finding their place in law enforcement organisations as useful members of the team where their work is not second-guessed, or their contributions dismissed. The role profiles in this study illustrate a more collaborative approach where crime scene staff (based on rank and experience) are expected to actively participate in investigations and take a proactive role in organisational and human development through knowledge exchange and intelligence transfer. It is unclear whether such HR literature translates to actual integration of scene staff into police/law enforcement infrastructures, however.

Scene examiners are understood to be vital to the investigative process but have been said to be underutilized and restrained by their perceived roles as technical assistants and/or evidence collectors only. Commentators have cited previous re-designations of Scenes of Crime Officers (SOCOs) as CSIs "to emphasize the role and reinforce the principle that the personnel are full members of the investigative team" (Blakey, 2000) as being less than successful in impacting perceptions of their role. These re-designations are evident in the almost non-existent SOCO role in UK law enforcement organisations where CSI has become the principal role descriptor for scene workers.

It has been argued that integration and acceptance of crime scene staff as members of the investigative team would aid the variation in perception of the role of crime scene practitioners (by those in the discipline, as well as others) would be possible, and notable improvements in the relationships between investigative units could be achieved (Fraser, 2000; Williams, 2004; Bradbury & Feist, 2005). Scene practitioners that assist in the 'investigative decision-making process' contribute to investigations through the 'provision of advice' and intelligence, and that effectively 'interact and work as a team' have been said to contribute to police enquiries much more effectively (SPSA, 2010). Present limitations in their perceived roles in volume crime

investigations mean the roles of crime scene examiners have become routinized and their training and knowledge are not fully exploited. The overall wording of the analysed role profiles alluded to this aspect and was seen to promote a more collaborative relationship between police staff and their scientific support counterparts.

Crime scene personnel are often described as professionals, but this is without any empirical basis. Occupations in general have been conceptualised in Western societies as an essential facet of daily life where individuals embody roles based on performance parameters that reflect their performance in society (Kantartzis & Molineux, 2011). Occupational science literature prescribes a framework for knowledge and research directions in the discipline. However, this requires some adjustment to be fit for the purposes of this thesis. Given that occupational science and its research tenets derived itself from occupational therapy, its overt focus on the relationship with health is a common theme (Yerxa et al. 1989; Clark et al. 1997; Wilcock, 1998; Law et al. 1998).

Gray (1997) prescribed a three-tiered framework which listed essential elements of the occupation, its processes unfolding over time, and its relationship to other phenomena as principal interests. The essential elements of an occupation can be summed up as the identification of the nature, substrates, structure, features or characteristics of that occupation. Processes refer to the investigation of the subjective experience, methods, features and outcomes of occupational performance. Its relationship to other phenomena refers to the explanations of the way that occupation interacts with social structures and policies, and concepts of identity, human development and value added to society.

Using this analytical framework, crime scene work can be said to be an all-encompassing discipline where technical, manual and specialist skills culminate in a variety of capacities and tasks, such as operational, investigative, administrative, organisational, intelligence and police work to undertake functions beyond the traditionally thought ‘bagging and tagging’ or those merely tasked with processing scenes. There are human resource and professional development paradigms to the work, with continued emphasis in the role profiles of scene staff taking charge as information hubs from where police personnel can draw experience and knowledge.

Scene practitioners can be said to add value to society, through continued community engagement where they may often be a point of contact for victims or their representatives. They not only are tasked with providing useful information but are also support systems who support through understanding and compassion after a crime has occurred, keeping in mind the impact such can have on members of society. Citizen perceptions of law enforcement are important. The co-production of social order and a more partnership-based approach can be a

driver for meaningful and cooperative relationships between communities and those tasked with maintaining the peace (Reisig & Giacomazzi, 1998).

The classifications or occupational paradigms formulated in this chapter can thus be used to study scene work and contextualise the role of scene staff in future studies, as analytical frameworks in this area are limited. Williams' (2004) typology of scene practitioners as either technical assistants or experts was useful to gauge whether any progress had been made in the decade since that study. In that model, scene staff were either experts (integrated into the investigative process) or assistants (integrated into organisational structure) had different responsibilities and had varying reach in terms of capabilities. The role profiles in the instant study showed a hybrid approach and combined both the assistant and expert models, to expand the scope of responsibilities and capabilities, based on Grades, or rank. Ludwig et al. (2012) found in a study on the perceptions of the main role of scene examiners by members of the discipline and other police staff, that the majority (38.2%) respondents perceived CSEs as merely evidence collectors, with 17.2% opting for a more dynamic and composite role with evidence collection, investigation, and specialist advice features.

However, though compelling, the data could not be used to conclusively argue for a case that scene practitioners can be elevated to the status of professionals. There have been attempts to define the boundaries of the discipline to ascertain whether their standing warranted a rethink as to their professional status, with limited success. No general criteria exist for crime scene practice, but the example of criminalistics (a related field) can be used to gauge the practical issues in declaring such disciplines as professions and plot further examination routes.

The term criminalistics was derived from the work of Hans Gross in the late 1940s to conceptually separate those working in police crime laboratories from the future police officers and social scientists studying criminology, criminal justice, and police science programs at colleges and universities (Morn, 1995). It was also to assist professionalize the scientific examination and interpretation of physical evidence with specific principles and practice arising out of criminology as well as the natural sciences. US-based forensic scientists progressively started to refer to themselves as criminalists and to their work as criminalistics (O'Hara & Osterburg, 1949). This rebranding was hailed by the police laboratory community, as evidenced by the literature and the formation of associated professional organizations, including the California Association of Criminalists (Chisum, 2011).

The question of whether criminalistics is a profession is thus more than half a century old (Kirk, 1963). It has been a particularly challenging question to answer due to the nature of professions being themselves underdefined. Medicine and the law represent traditional norms of professions, but in popular usage, the word is copiously applied to almost any habitual

occupation. A prevalent example is the terming of sex workers as being individuals engaged in the “oldest profession”, and in sports, the word “pro” is used to clearly demarcate elite athletes from the supposed amateurs. Societal understanding of these designations assists in recognition of the differences between a profession and what may only be a vocation. The growth of professional colleges in universities has lent perceived respectability to the expansion of ranks within professions. The three main criteria that was suggested for criminalistics to be considered an academically-based profession are formal education, a code of ethics, and demonstration of competency (Kirk 1963). The criteria generally applied by the universities would appear sufficient for a determination of this status.

1. Professions are founded on an extensive period of training at a high educational level. In general, university or college work of considerable duration is necessary to qualify in the recognized professions (Moore, 1970; Abbott, 1981; Schwartz & Bryan, 1998, Cheetham & Chivers, 2005).

2. A profession is characterized by some generally recognized and accepted code of behaviour or ethics. The professional has been argued to be someone who must be minister to the people (Reingold, 1987).

3. A profession requires established competence (Hager & Gonczi, 1996). This requirement may seem to be subsidiary to (1) above, e.g. graduates of medical schools may not practice without being examined by a licensing board (Lundgren & Houseman, 2002).

For crime scene practice to be considered a profession, and by extension scene practitioners as professionals, critical questions about the training, competence and codes they abide require examination. Institutions which claim to train in scene practice may fall far short of their stated objectives, without a mechanism to assess the quality of their offerings. Supposing satisfactory courses are available, there is no guarantee that a trainee who has passed these courses is ready to assume professional practice. Licensing, certification, or some other indication attesting a person’s competence could help in this. There is therefore need for serious consideration of this problem, and determination of the criteria of qualification for scene practitioners.

Another key aspect which was mentioned in role profiles across the board was quality, and the need for it, however, there was little to no elaboration on how this was to be achieved, and as literature on the subject is also limited, a comprehensive examination of the same is warranted (and follows in the next chapter) if any semblance of completeness is to be achieved in the understanding the nuances of scene practice.

CONCLUSION

Collected role profiles from the large dataset provided a useful guide as to the principal responsibilities of crime scene staff at UK police forces. The striking similarity in duties prompted questions as to whether CSI, CSE and SOCO classifications had any justification to exist separately, where CSI was the predominantly advertised choice. A wide-range of intelligence-related tasks, which are seldom included in literature, shed light on practitioners often dismissed as technicians or tradesmen. Instilling the values of police organisations and expecting abidance to the same illustrated a willingness for law enforcement to bridge the gap between officers and crime scene staff, who for a long-time were not considered part of the police despite incorrectly being labelled as doing 'police work'. The data also showed that the space between previously formulated conceptualisations of crime scene practitioners as 'technical assistants' or 'expert collaborators' was getting closer, as responsibilities in profiles across the board alluded to tasks which had elements of both. Disambiguation of crime scene work could pave the way for centralised policymaking and instil a more universally accepted standard. Role profiles illustrated a wide variety of accepted courses from different training and educational organisations. Without consideration of the role of these bodies, their internal and external validity, and interaction with the discipline, the health and future of the same cannot be stated or speculated. As a consequence, Chapter Six will examine this in detail.

5.3 FORENSIC SCIENCE FINANCES

ENGLAND

Table 5c

Crime Scene

		Y		E	A	R	S	
No.	**Name**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
		£						
1	Devon & Cornwall Police	3,906,921	3,706,267	3,107,311	3,446,278	3,296,801	3,476,501	
2	Durham Constabulary				1,579,446	1,431,659	1,586,964	
3	Essex Police		3,273,918	3,598,418	3,559,876	3,626,381	3,626,381	2,976,056
4	Gloucestershire Constabulary	1,076,139	1,057,940	993,135	853,987	773,414	715,110	665,110
5	Greater Manchester Police	17,095,656	9,964,700	5,818,477	10,626,491	5,422,854	5,372,844	
6	Hampshire Constabulary				2,351,037	2,598,197	2,451,867	2,770,939
7	Kent Police		3,049,042	2,547,323	2,119,060	2,215,700	2,224,408	2,157,911
8	Lancashire Constabulary		2,206,365	1,988,043	2,215,140	2,160,427	1,913,152	
9	Lincolnshire Police		1,052,924	1,107,154	1,067,245	1,067,245	1,043,615	
10	Merseyside Police			2,794,208	2,716,461	2,348,312	2,328,295	
11	Metropolitan Police Service	23,682,000	25,971,000	28,801,000	28,253,000	27,624,000	26,855,000	21,437,000
12	Norfolk & Suffolk Constabulary				1,940,092	1,832,270	1,999,905	
13	North Yorkshire Police	1,285,196	1,263,775	1,253,050	1,162,969	1,500,607	1,273,677	824,992
14	Sussex Police			1,402,243	2,435,410	224,053	2,395,977	1,599,176
15	Thames Valley Police			2,928,681	2,793,213	2,650,565	2,500,165	1,694,420
16	West Midlands Police		4,721,700	4,110,400	4,166,300	4,019,600	3,902,100	
17	West Yorkshire Police	4,446,086	4,252,817	3,885,160	3,812,197	3,981,738	4,552,769	3,070,438
18	Wiltshire Police				718,505	663,409	689,676	489,105

Key Findings

Eighteen (18) forces from England provided data for at least one (1) year of the range provided in the Freedom of Information (FOI) request. Four (4) forces (Gloucestershire Constabulary, Metropolitan Police Service, North Yorkshire Police, and West Yorkshire Police) supplied data for all seven (7) years of data that was sought. The Metropolitan Police was consistently the highest spender on crime scene work, with Greater Manchester Police coming in second, and

West Yorkshire Police, third. Gloucester Constabulary was the only force which showed a steady decline in spending from year one to year seven.

<u>Laboratory Expenses</u>

Table 5d

No.	Name	YEARS						
		£						
		1	**2**	**3**	**4**	**5**	**6**	**7**
1	Derbyshire Police	2,237,763	1,437,801	1,027,166	1,012,019	1,207,008	968,374	878,441
2	Devon & Cornwall Police	187,291	180,065	184,566	157,827	153,322	187,447	
3	Durham Constabulary	956,492	961,316	913,034	873,871	966,557	851,460	
4	Essex Police		3,912,008	3,009,597	2,290,267	2,001,646	2,384,814	2,736,955
5	Hampshire Constabulary			277,369	746,641	688,058	632,403	742,776
6	Kent Police		3,422,363	2,412,368	2,103,840	1,753,913	2,467,400	2,307,882
7	Lincolnshire Police		1,694,830	1,799,334	977,267	890,359	697,274	642,820
8	Merseyside Police			2,405,028	2,290,330	2,454,253	2,405,266	
9	Metropolitan Police Service	12,438,000	9,055,000	9,713,000	13,096,000	11,343,000	10,682,000	10,003,000
10	Norfolk & Suffolk Constabulary				1,705,284	1,930,824	1,724,279	
11	North Yorkshire Police	1,445,218	1,029,766	682,395	474,966	14,573		
12	Sussex Police			1,337,082	2,010,985	1,828,505	1,560,040	1,117,899
13	Thames Valley Police			443,015	423,768	409,441	404,001	236,450
14	West Midlands Police		4,045,400	3,373,900	2,202,800	1,986,300	2,104,800	
15	West Yorkshire Police	5,683,327	4,142,715	3,654,152	3,356,437	3,894,317	3,366,891	2,400,955
16	Wiltshire Police				39,036	56,738	30,656	

Key Findings

Sixteen (16) forces from England provided data for at least one year of the range sought in the FOI request. Three (3) forces (Derbyshire Police, Metropolitan Police Service, and West Yorkshire Police) provided all seven (7) years of data. The Metropolitan Police Service was again the highest spender, this time, on lab work. There was a trend of decreasing spending, with each force spending less in the final two years (as provided individually) than they had done in the first year.

Overall Scientific Support Costs

Table 5e

		Y		E	A	R	S	
No.	**Name**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
					£			
1	Bedfordshire Police	2,698,300	2,993,300	2,794,400	2,609,700	2,791,400		
2	Cambridgeshire Constabulary		3,639,396	3,121,587	3,161,429	3,224,665	3,167,189	3,133,672
3	Derbyshire Police	6,484,413	5,400,592	4,621,989	2,816,063	2,865,919	2,652,197	
4	Devon & Cornwall Police	7,336,415	6,886,542	6,318,469	6,040,457	5,882,150	6,399,251	
5	Durham Constabulary				2,783,627	2,756,242	2,767,150	
6	Essex Police		9,855,802	9,202,717	8,459,358	8,001,471	7,349,936	7,477,869
7	Gloucestershire Constabulary	1,229,696	1,145,414	1,113,825	1,096,858	1,050,913	896,007	963,458
8	Greater Manchester Police	24,161,355	18,565,330	17,003,925	15,779,795	13,843,266	14,248,222	
9	Hampshire Constabulary	11,578,465	10,470,827	8,924,256	8,814,602	8,095,457	7,795,819	8,617,342
10	Kent Police		10,614,097	8,500,967	7,475,448	6,795,866	7,193,220	6,963,810
11	Lancashire Police		8,678,027	7,451,503	7,521,153	6,551,661	5,240,347	
12	Leicestershire Police			3,675,000	3,815,000	3,507,000	2,549,000	
13	Merseyside Police			5,199,236	5,006,791	4,802,565	4,733,561	
14	Metropolitan Police Service	38,214,000	33,924,000	22,758,000	15,328,000	13,562,000	17,802,000	14,167,000
15	Norfolk & Suffolk Constabulary				4,922,006	5,484,587	5,023,324	
16	North Yorkshire Police	4,267,114	3,896,119	3,277,154	3,176,486	3,271,273	3,574,141	2,650,665
17	Northamptonshire Police	4,266,603	2,155,037	2,714,277	2,698,643	2,699,363	2,220,363	
18	Nottinghamshire Police	1,682,676	1,806,188	1,936,156	1,748,020	1,729,765	1,601,118	1,430,476
19	Sussex Police			3,705,824	5,796,630	5,298,079	5,047,358	3,426,066
20	Thames Valley Police			6,854,982	6,666,597	6,608,164	6,270,932	3,955,887
21	West Midlands Police	11,975,000	18,691,000	16,462,000	13,890,000	13,860,000	11,451,000	

22	West Yorkshire Police	18,801,127	17,280,283	14,114,580	15,726,777	14,374,800	11,676,487	11,890,808
23	Wiltshire Police				3,159,266	2,702,995	2,501,382	1,144,045

Key Findings

There were 23 datasets that were fit for the purpose of this section, meaning they were properly labelled, given in usable format, and explained in the FOI response as the data that was sought in the request. There were six (6) forces (Hampshire Constabulary, Gloucestershire Constabulary & Lincolnshire Police, Metropolitan Police Service, North Yorkshire Police, Nottinghamshire Police, and West Yorkshire Police) which provided data for all seven (7) years that was requested. Six (6) forces (Derbyshire Police, Devon & Cornwall Police, Essex Police, Kent Police, Northamptonshire Police, and West Midlands Police) produced figures for six (6) years of data.

The Metropolitan Police Service led the spending, with Greater Manchester Police coming in at second, followed by West Yorkshire Police and West Midlands Police. The Met Police demonstrated a steady decline, with lower spending every year from year one to year seven, with a spike in year six, but figures significantly lower than the first year. The declining trend was also seen at Greater Manchester Police, with again, a slight rise in year six.

WALES

Crime Scene

Table 5f

		Y		**E**	**A**	**R**	**S**	
No.	**Name**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
					£			
1	Dyfed-Powys Police	694,456	675,406	721,455	776,160	834,831	813,472	748,144
2	Gwent Police	2,519,662	2,505,307	2,398,561	1,910,332	1,932,180	2,078,716	1,890,504
3	North Wales Police	1,469,772.43	1,498,960.26	1,427,696.91	1,473,732.09	1,447,027.49	1,429,463.61	1,477,314.03
4	South Wales Police			2,126,617	2,175,367	2,126,617	1,868,954	1,865,093

Laboratory Expenses

Table 5g

		Y		E	A	R	S	
No.	**Name**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
		£						
1	Dyfed-Powys Police	1,437,462	1,297,391	1,606,088	1,446,804	1,455,755	1,308,352	1,526,948
2	Gwent Police							
3	North Wales Police	121,683.22	121,523.08	119,496.16	131,231.34	208,162.47	214,573.54	172,276.01
4	South Wales Police			1,783,062	1,716,504	1,791,087	1,597,788	1,812,381

Overall Scientific Support Costs

Table 5h

		Y		E	A	R	S	
No.	**Name**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
		£						
1	Dyfed-Powys Police	1,552,697	1,435,119	1,716,160	1,569,759	1,602,647	1,493,147	1,608,783
2	Gwent Police	3,903,952	3,848,527	3,862,941	3,297,016	3,302,881	3,512,224	3,377,276
3	North Wales Police	5,220,371.66	4,761,137.91	4,860,313.58	4,599,512.24	4,256,737.46	4,302,325.24	4,570,675.14
4	South Wales Police	4,051067	3,657,529	4,309,138	4,303,594	4,288,194	4,175,341	4,329,984

SCOTLAND

Crime Scene

Table 5i

		Y		E	A	R	S	
No.	**Name**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
		£						
1	Police Scotland					7,317,000	7,270,000	

Laboratory Expenses

Table 5j

		Y		E	A	R		S
No.	**Name**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
		£						
1	Police Scotland					14,501,000	14,404,000	

Overall Scientific Support Costs

Table 5k

		Y		E	A	R		S
No.	**Name**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
		£						
1	Police Scotland					25,809,000	26,491,000	

NORTHERN IRELAND

Overall Scientific Support Costs

Table 5l

		Y		E	A	R		S
No.	**Name**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
		£						
1	Police Service of Northern Ireland			18,751,000	19,098,000	19,143,000	17,659,000	17,02,1000

Key Findings

In Wales, the individual police forces did not show any consistency or pattern in spending in either of the three headers. Spending for crime scene work was less in the sixth year in every category, compared to the first year, in all but one of the forces (Dyfed-Powys). The same Force showed a different picture in laboratory expenses, where the spending in the seventh year was more than the first year, after a dip in the sixth. North Wales Police experienced higher spending for years five, six and seven, with the highest recorded figures in the latter for lab expenses. There was no discernible pattern in spending for the 'overall scientific spending' header, with numbers fluctuating from one year to the next.

Police Scotland only provided data for years five and six, and while numbers showed a downward trend, i.e. about 0.64% in crime scene expenses, and about 0.66% in laboratory costs; there was an increase of about 1.03% in overall scientific support costs.

Police Service of Northern Ireland returned data for years three to seven, with an overall downward trend in the one category they provided (Overall Scientific Support Costs).

Summary of Findings

Analysing the financial data provided by a mixed understanding of the record-keeping practices but did not assist with any real understanding of the effect of austerity on crime scene expenses. In England, there was a dip in expenses in year five compared to year four, but this could not be classified as a trend, due to several forces seeing a rise in spending during the same year. Five out of six forces did show less spending in year six than in year one but again, this could not be attributable to any general trend due to inconsistencies in the previous and following year(s). In Scotland, year six also showed a lower crime scene spending figure than year five, with three out of four forces in Wales displaying the same phenomena.

Laboratory expenses in England were generally lower in year five than it was in year one, with the same general trend in year six and year seven, with some exceptions. Welsh police forces did not exhibit this trend, and their expenses were higher in the seventh year than the first for two forces, with one force not providing data, and the other showing the highest amount spent on laboratory expenses in the entire seven-year period. Police Scotland provided only two years of data, and it did not contribute to any attributable understanding other than year six had lower figures than year five.

The trend of missing data was evident in the overall spending on scientific support as well, with only six (6) out of 23 participating police forces in England able to provide data for all seven years, with Scotland providing data for two years (years five and six) and Northern Ireland doing better with data from years three to seven (missing one and two). Wales came out on top with data from all four forces, which assisted in understanding the size of the forces in terms of spending on scientific support, with respect to all seven years: (1) North Wales Police; (2) South Wales Police; Gwent Police; and Dyfed-Powys Police. Due to missing data, and incomplete information, such a determination could not be conclusively made for England, although the Metropolitan Police and Greater Manchester Police did show great reductions in their overall spending from year one to year seven, and West Midlands and West Yorkshire trailing them in spending numbers. Gloucester Police consistently had the lowest figures in the years they provided data in relation to other forces in the same year.

5.4 CRIME SCENE WORK AND ITS PERSONNEL

Crime Scene Personnel Numbers

Personnel numbers were difficult to collate, as they were provided in a variety of formats. Some forces sent numbers which were headcount figures, while others gave Full-time Equivalent (FTE) amounts. There was also discrepancy in the manner in which these numbers were framed. Some sent in numbers for '2009' while others provided '2009/10' making it difficult to ascertain the start and end dates. As the data was sought as a period between (2009-2015), the data was labelled as years 1, 2, 3…7 for trend representation. Headcount figures therefore needed to be separated from FTE. There were also four forces which did not participate at all, and one which provided partial information. The data could therefore not be used to conclusively declare the total number of crime scene personnel in the UK between the 2009-2015 period. However, they did afford scope for examining the trends in numbers before and after the closure of the Forensic Science Service (FSS) which closed down in 2012. The Conservative Party had been in power since 2010 and were said to employ austerity measures across public services. The period thus provides useful data on how forces reacted to these measures and whether it had any impact on crime scene personnel numbers.

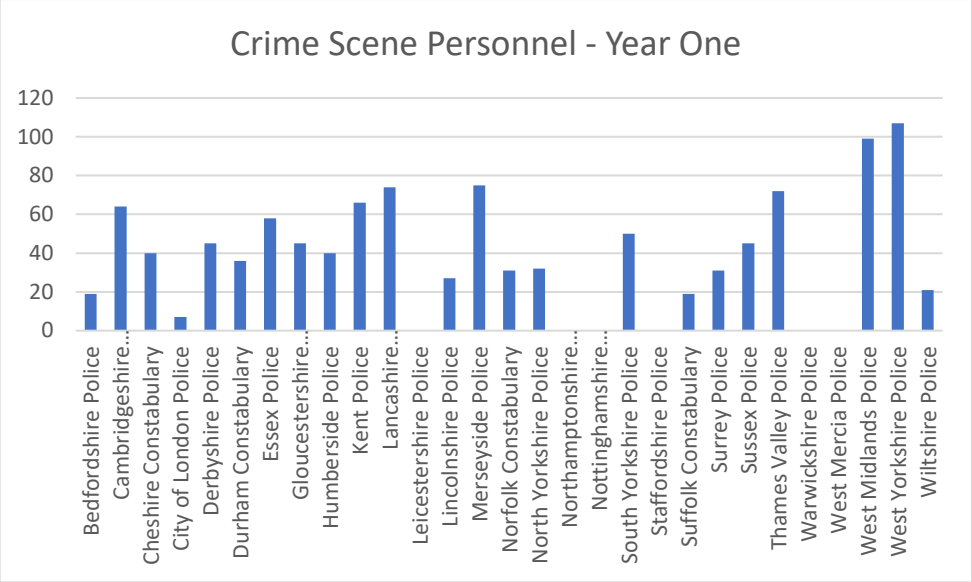
ENGLAND

Headcount

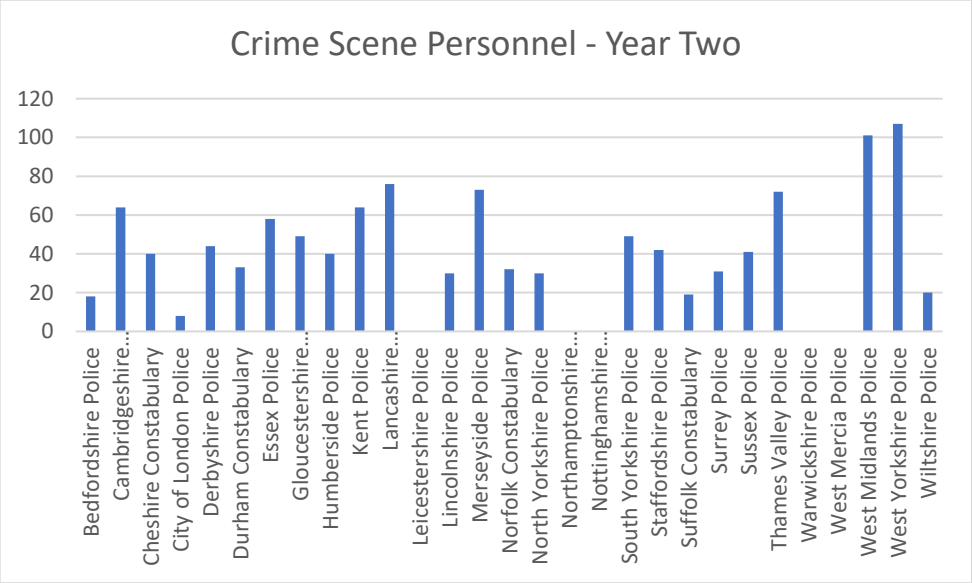
Table 5m

HEADCOUNT FIGURES FOR POLICE FORCES IN ENGLAND (2009-2015)								
		Y	**E**	**A**	**R**	**S**		
No.	**Name**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1	Bedfordshire Police	19	18	20	21	20	22	
2	Cambridgeshire Constabulary	64	64	59	54	53	56	64
3	Cheshire Constabulary	40	40	40	40	27	27	27
4	City of London Police	7	8	8	8	8	8	7
5	Derbyshire Police	45	44	43	38	35	36	35
6	Durham Constabulary	36	33	31	31	31	30	29
7	Essex Police	58	58	58	54	53	53	53
8	Gloucestershire Constabulary	45	49	54	22	23	21	21
9	Humberside Police	40	40	36	34	34	32	

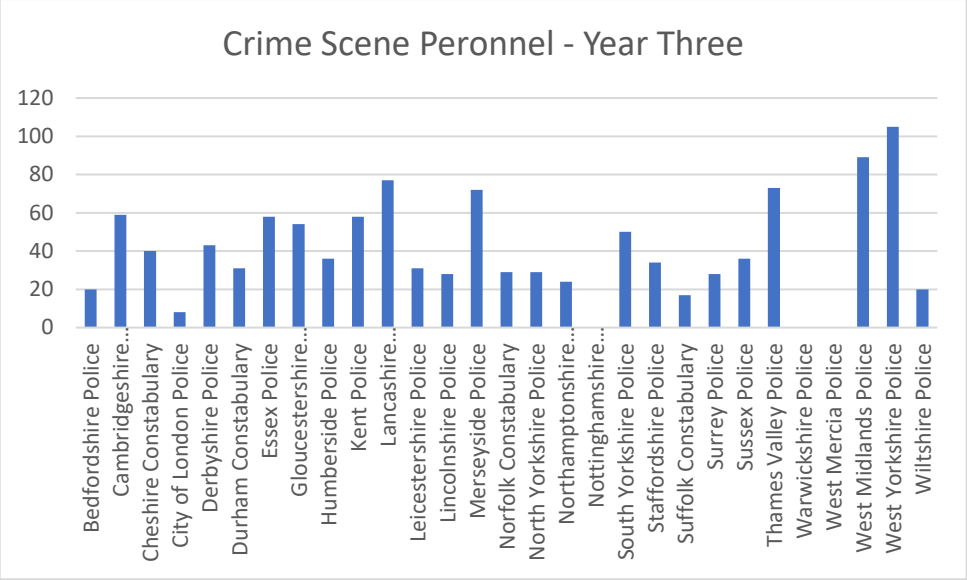
10	Kent Police	66	64	58	54	55	57	55
11	Lancashire Constabulary	74	76	77	—	—	—	—
12	Leicestershire Police	—	—	31	31	28	27	27
13	Lincolnshire Police	27	30	28	25	24	24	22
14	Merseyside Police	75	73	72	69	53	52	—
15	Norfolk Constabulary	31	32	29	27	31	28	25
16	North Yorkshire Police	32	30	29	28	26	26	26
17	Northamptonshire Police	—	—	24	28	29	28	29
18	Nottinghamshire Police	—	—	—	—	—	—	30
19	South Yorkshire Police	50	49	50	44	40	40	38
20	Staffordshire Police	—	42	34	36	33	29	29
21	Suffolk Constabulary	19	19	17	16	16	15	14
22	Surrey Police	31	31	28	27	27	31	32
23	Sussex Police	45	41	36	30	38	38	42
24	Thames Valley Police	72	72	73	70	66	68	64
25	Warwickshire Police	0	0	0	2	44	42	46
26	West Mercia Police	—	—	—	—	—	—	—
27	West Midlands Police	99	101	89	89	97	93	91
28	West Yorkshire Police	107	107	105	89	84	84	84
29	Wiltshire Police	21	20	20	18	18	19	19
	TOTAL	1103	1141	1149	985	993	986	909



In the first year, West Yorkshire Police had the highest number of crime scene staff (107) while the City of London Police had the lowest (7). West Midlands Police was second with (99) staff members. Leicestershire Police, Northampton Police, Nottinghamshire Police, Warwickshire Police and West Mercia Police did not participate, even though they did provide data for at least one of the seven years of number sought in the FOI request.

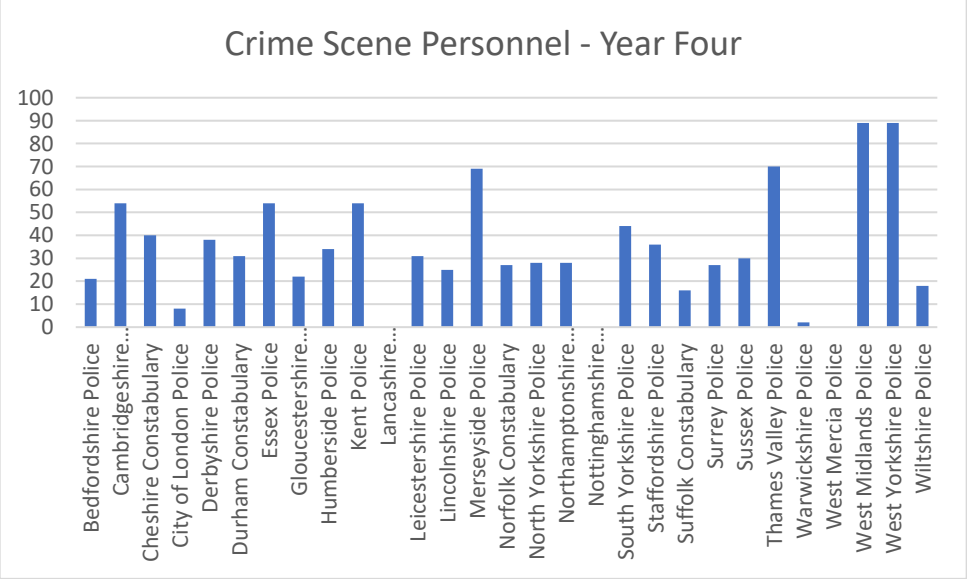


In the second year, West Yorkshire Police had the same number as the previous year (107), but West Midlands Police increased to (101). Gloucestershire Police made the biggest additions with four (4) members being added. Sussex decreased their numbers by the same number (4). Staffordshire provided data from this year. As Staffordshire did not provide data for the first year, their numbers were removed from comparison values for the first year, so that an even comparison could be made. The average percentage change, across all participating forces from the previous year was minus (-) 0.36.

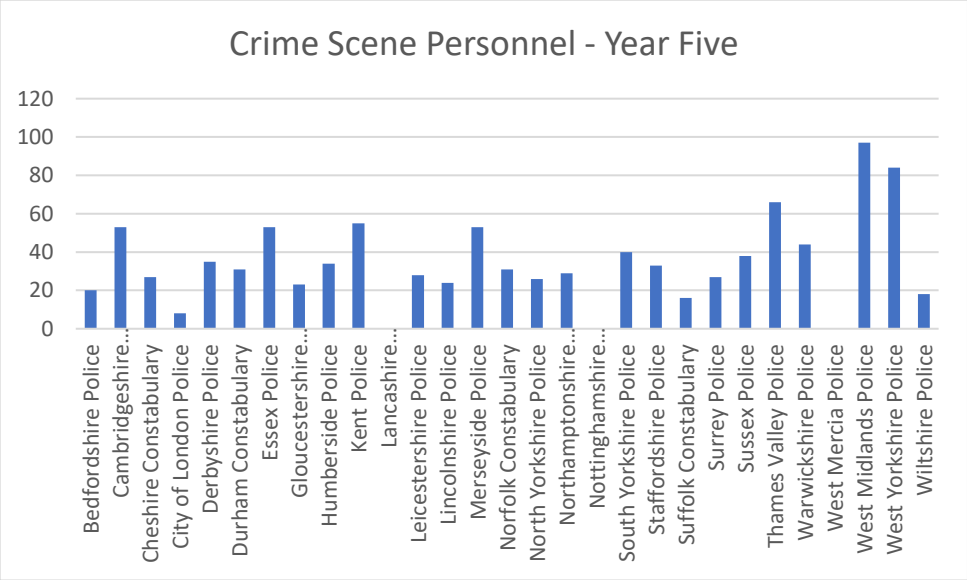


There were various additions and lowering of numbers across all forces. Cheshire Constabulary, City of London Police, Essex Police, and Wiltshire Police kept the numbers same as the previous year. The biggest additions were made to Gloucestershire Constabulary for the second year running with five (5) taking their overall number to 54. West Midlands decreased their numbers the most, by 12, finishing with 89 from the previous year's 101. It was the same as West Yorkshire Police finished with the 105. Staffordshire also cut their numbers by eight (8) coming down from 42 to 34.

Leicestershire Police and Northamptonshire Police did not provide data for the first two years, and so, overall percentage change comparison with the previous year would require their removal. The remaining forces would then be compared. The overall change was minus (-) 4.12%.

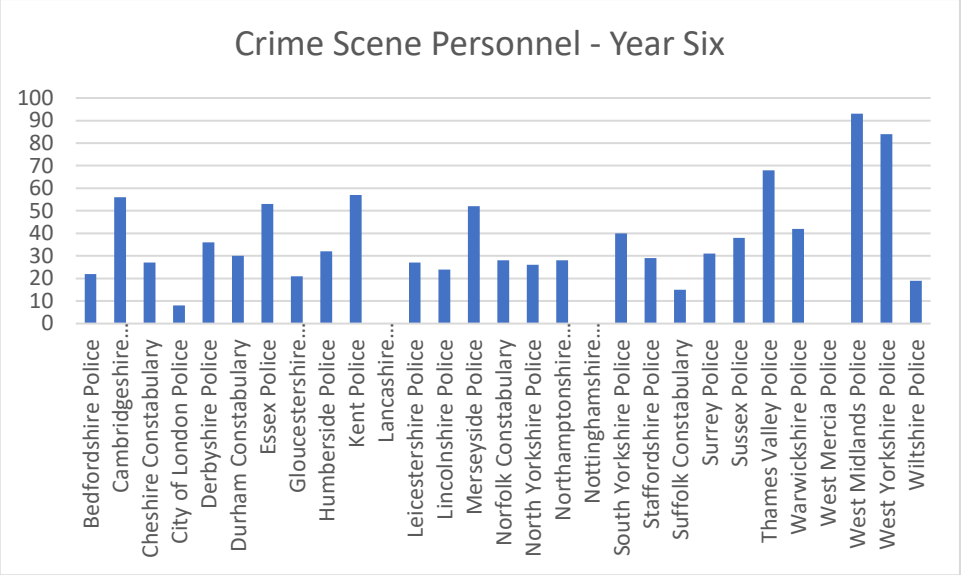


In the fourth year, West Yorkshire Police, and West Midlands Police had the same number of crime scene staff (89) while the Warwickshire Police had the lowest (2). Gloucestershire Constabulary saw a major drop from 54 in the previous year, to 22. Lancashire Police did not provide data for years four through seven. This greatly affected the numbers and calculating average percentage change between the previous and current years. Lancashire was therefore taken out of year three for a more accurate comparison of change(s). The average change was minus (-)8.12% from the previous year.

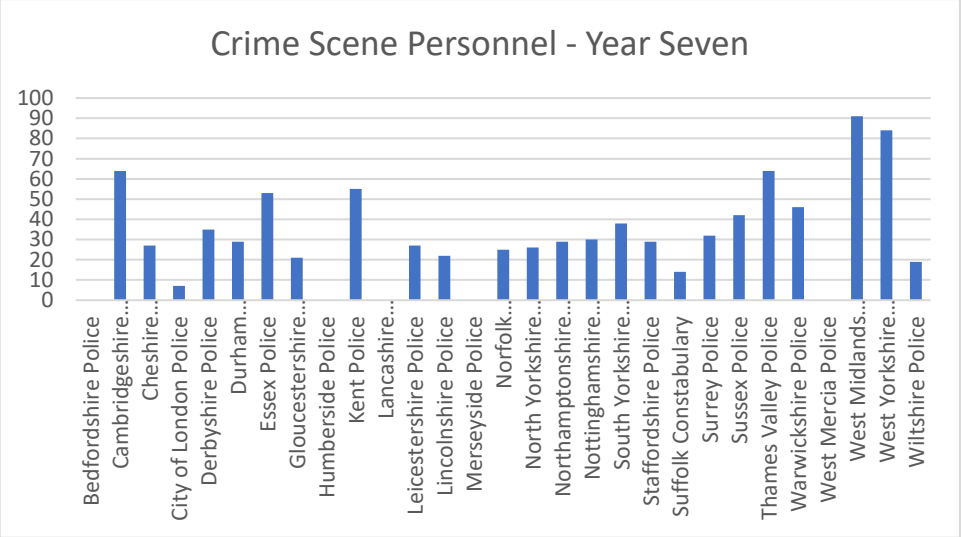


The fifth year an increase to the West Midlands Police numbers to 97, making it the highest in the year. West Yorkshire dropped to 84. Merseyside Police made a significant cut from 69 in the previous year, to 53 (a deduction of 16). Cheshire Police were second in reducing numbers, by cutting their workforce to 27, from 40 in the last year (a reduction of 13). Sussex Police added 8 to their numbers, taking it to 38. Thirteen (13) out of the 27 participating forces saw cuts to their numbers. There were increases to seven (7) forces, while numbers remained the same for the remaining seven (7).

The average percentage increase, bearing in mind participating forces adjustments, was 0.81%.



In the sixth year, ten (10) forces decreased their numbers with the most significant reductions being four (4) each by West Midlands Police, and Staffordshire Police. Noteworthy increment was seen in terms of Warwickshire Police, from two (2) in the previous year to 44. The percentage change between year five and year six was minus (-) 0.70.



In the seventh year, there was an increase to the workforce in Cambridgeshire Constabulary by eight (8) taking their overall from 56 to 64. Sussex added four (4) to their numbers, as did Warwickshire Police. Lincolnshire Police had four (4) fewer crime scene practitioners, as did Thames Valley Police. As several forces, including Bedfordshire, Humberside, and Merseyside did not provide data for this year, it was difficult to calculate the difference in staff numbers. Nottinghamshire was a new addition.

Taking out these forces from the previous year (and current year), revealed that the percentage change was minus (-)0.114 for the seventh year.

WALES

Table 5n

HEADCOUNT FIGURES FOR POLICE FORCES IN WALES (2009-2015)								
		Y	E	A	R	S		
No.	**Name**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1	Dyfed-Powys Police	15	15	13	13	14	12	12
2	Gwent Police	7	7	9	9	8	8	12
	TOTAL	22	22	22	22	22	20	24

The two forces in Wales were consistent in their overall headcount numbers with years one (1) to five (5) having the same combined figure (22) with a slight decrease in year six (20) and the highest in year seven (24). It is worth noting that Gwent Police increased their numbers from year 1 to 7, by almost 42%, while Dyfed-Powys Police decreased from the first year to the final year, by 20%.

NORTHERN IRELAND

Table 5o

HEADCOUNT FIGURES FOR POLICE FORCES IN NORTHERN IRELAND (2009-2015)								
		Y	E	A	R	S		
No.	**Name**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1	Police Service of Northern Ireland	146	151	155	156	156	147	131

Police Service of Northern Ireland saw increases over the first two years, rising from 146 to 151, and then 156 in years four and five, after which there was a reduction in year six to 147, and then in year seven, showing the lowest figures in since year one, through a reduction of fifteen (15) staff members.

ENGLAND AND WALES

Full-Time Equivalent (FTE)

Table 5p

FULL-TIME EQUIVALENT (FTE) FIGURES FOR POLICE FORCES IN ENGLAND (2009-2015)								
				Y	E	A	R	S
No.	**Name**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1	Devon & Cornwall Police		38	37.5	36.5	37	35	36
2	Greater Manchester Police	222.23	209.63	200.63	197.77	232.25	217.38	223.24
3	Hampshire Constabulary	31.43	41.15	42.09	42.37	43.83	48.06	47.65
4	Hertfordshire Constabulary	38.85	35.35	33.36	31.13	37.66	36.71	35.99
5	Metropolitan Police Service	357	333	329	314	311	305	—
6	Northumbria Police	46	56	55.5	49	37	38	37.5
7	Northamptonshire Police	—	—	22.5	25.78	25.78	26.28	26.72
8	West Midlands Police	97.56	99.62	87.92	87.85	96.43	92.31	90.11
	TOTAL	793.07	812.75	808.50	784.40	820.95	798.74	497.21

Table 5q

FULL-TIME EQUIVALENT (FTE) FIGURES FOR POLICE FORCES IN WALES (2009-2015)								
				Y	E	A	R	S
No.	**Name**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1	North Wales Police	29	29	30	29.61	29.61	30.61	30.61
2	South Wales Police	34.50	31.50	33.50	30.50	27.56	28.05	26.05
	TOTAL	63.50	60.50	63.50	60.11	57.17	58.66	56.66

SCOTLAND

Table 5r

FULL-TIME EQUIVALENT (FTE) FIGURES FOR POLICE FORCES IN SCOTLAND (2009-2015)								
				Y	E	A	R	S
No.	**Name**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1	Police Scotland					102.80	100.80	98.5

Full-time Equivalent (FTE) figures illustrate the hours worked by one member of staff on a full-time basis. The concept can be used to convert the hours worked by several part-time workers into the hours worked by full-time staff. FTE numbers were provided by eight (8) forces in England, however, only five (5) forces gave data for all seven (7) requested years. All eight forces provided data for years three to six, which showed no discernible trend, other than year four having the lowest figures (784.40) and year five (820.95) being the highest.

The two forces in Wales which provided FTE figures showed a decreasing trend from year five onwards, with constituently lower figures compared to years one to four.

Police Scotland only made years five to seven available, which showed an overall decreasing trend, starting with 102.80, coming down to 100.80 and then in year seven, the lowest figure of 98.5.

Key Findings

Sixteen (16) out of 29 forces in England showed lower numbers in year seven than year one, and there was generally lower figures or maintenance of similar headcount numbers in comparison to year one, in years five and six. The two forces in Wales had similar numbers in their overall headcount figures with years one (1) to five (5) having the same combined figure (22) with a slight decrease in year six (20) and the highest in year seven (24). One force (Gwent Police) increased their numbers from year one to seven, by almost 42%, while Dyfed-Powys Police decreased from the first year to the final year, by 20%. Police Service of Northern Ireland experienced consistently higher headcount numbers after year one, with the highest numbers of scene staff in years four and five, with decreases in years six and seven. FTE figures showed that the Metropolitan Police were the biggest police force in the UK with the highest numbers of scene personnel, followed by Greater Manchester Police. The data provided by Scotland showed that it employed comparable numbers to West Midlands Police and significantly lower than Police Service of Northern Ireland. Taking headcount and FTE data into consideration (as well as non-participants and potential size of missing forces), the overall size of the crime scene staff in England & Wales can be estimated to be about 1% of the overall size of the police workers, taking into account official government data.

Discussion

The data analysed in this chapter shows a trend of decreasing crime scene practitioner numbers. There has also been a general trend in police forces across jurisdictions decreasing overall spending on scientific support. Crime scene spending and laboratory expenses was a mixed bag, but more forces reduced costs than those that increased. It is difficult to correlate these reductions as no official data exists on the proposed or implemented cuts to forensic science expenses by the Conservative government in the periods outlined. However, as the cuts applied to policing as a whole, and forensic science budgets come out of the overall budgets for forces, it can be argued that fiscal austerity measures may have played some part in the way. The closure of the Forensic Science Service (FSS) was also a major event in the UK forensic science market, and its effect was also a matter of consideration. There was, however, no discernible knock-on effect that could be highlighted to conclusively establish or deny any of the concerns held prior to, or immediately following its closure concerning the forensics market.

Government agenda-driven engagement in forensic science, however, as in most aspects of policing and criminal justice, cannot be stated to be a new phenomenon. Modern forensic science operates and has operated across the United Kingdom at all levels of crime investigations and relies on government investment and strategies. The DNA expansion programme and the creation of a commercial market (in England and Wales) to provide forensic science laboratory services to the police and other law enforcement agencies can be said to be agenda-driven initiatives (Cooper & Mason, 2009). These strategies, though heavily touted to be fit for the purpose of advancing forensic science, have not always lived up to the expectations and demands of practitioners or even Parliament, leading to unfavourable reports by the House of Commons Science and Technology Committee (House of Commons, 2005; 2011), the latter exploring the Conservative government's decision to close, through a managed wind down, the Forensic Science Service.

The closure could be argued to be a result of the privatisation of forensic laboratory services which left the FSS unable to compete in a shrinking market shaped by reduced spending, as police forces were forced to manage reductions to their budgets. On the other end of the spectrum, the political agenda was evident in the Coalition Agreement under the heading of 'Freedom, Fairness and Responsibility' with the government seeking to introduce protections around the National DNA Database. It led into the Protection of Freedoms Act (2012), which attached new rules for the retention and destruction of fingerprints, DNA samples and footwear impressions, as well as the creation of a new post of Commissioner for the Retention and Use of Biometric Material. Other government planned initiatives included streamlined forensic reporting as a subset of the swift justice agenda. Sustained government cuts to overall police revenue funding, coupled with a significant fall in officer numbers, down from 143,769 in 2009 to 122,404 at the end of 2018, have been observed. Political and government agendas have arguably shaped forensic science in the United Kingdom over the past four decades, no more so than through investment (such as the DNA expansion programme) or recently the cuts in police budgets.

It can be a challenge to accurately assess the effect of the reductions in police spending on forensic science services since the announcement of the comprehensive spending review in October 2010, or to predict the shape and size of the market in the days to come. The forensics market drastically shrank in recent years, from around £170 million in 2009 to around £110 million by 2015 (House of Commons, 2013). It was attributed to a myriad of factors including, increased efficiency; closer work with prosecutors, and the completion of the previous Government's DNA Expansion Programme. These claims cannot be conclusively established, though.

The figures publicly released do not often represent the spending by police forces beyond that which is allocated to purchase forensic laboratory services, notably excluding the amounts spent internally by forces on actions such as crime scene investigation, fingerprint comparisons etc. Police spending in the commercial market that provides forensic science laboratory services has been steadily shrinking and is predicted to continue doing so. Equally, as police budgets continue to come under pressure to achieve savings, cost reduction measures can be expected to curb internal spending on forensic services and to establish new ways of working, such as through regional collaboration programmes, akin to the joint project between Derbyshire, Nottinghamshire and Lincolnshire police forces (as found in FOI requests in this thesis).

The consequences of the 2008 financial crisis and the subsequent debt crises affecting European countries including the UK contributed to new policies. The latter embarked on widespread austerity programmes of cutbacks in public expenditure, including reductions of 20–30% in spending on policing (Edwards & Hughes, 2012). It spawned questions about the impact of such measures and the potential disruption of mainstay policing dispositions and further production of new challenges in criminal justice. The impact of austerity on the wider justice mechanisms and risk management agendas during a time of widespread metropolitan policing problems are however a concern.

In terms of the effect of these crises and the austerity policies on security, predictions made by politicians, media, commentators, and criminal justice actors, increases in public disorder and crime have not been established as a direct consequence of those policies. Recorded crime showed a downward trend in recent years at the national level leading up to 2018, with a spike that same year. The Home Office data published by the Office for National Statistics (ONS, 2018) showed police forces in England and Wales registered a total of 5.6 million offences in the first half of 2018, compared with 5.2 million offences in the previous 12 months. The number of homicides - including murder, manslaughter and infanticide hit the highest point for more than ten years, with a rises each year for four consecutive years.

Home Office (2018a) figures suggested that Only 9% of crimes end with suspects being charged or summonsed in England and Wales. In the 12 months leading up to March 2018, 443,000 crimes resulted in a charge or summons out of 4.6 million offences. It was stated to be the lowest detection rate since 2015. The figures also indicated that the police closed nearly half (48%) of all cases because no suspect could be identified. The statistics on crime outcomes alluded to a decreasing success of the police at catching criminals against a backdrop of rising crime. Overall, crimes recorded by police went up 11% between March 2017 and the twelve months that followed. While crime rates might only have limited correlation between

commission of more offences and forensic science investment and crime scene practitioner numbers, there is a far stronger argument for decreasing crime solving and case closing rates and the same.

Austerity measures in North America, the UK, and elsewhere around the world have had an observable effect on police funding, already under pressure from the increasing costs of policing a high threat, interconnected, post-9/11 landscape (Boyd et al. 2011). Pressures on police can lead to increasing recourse by citizens to private security services, in a similar manner that is commonplace in high-crime societies such as South Africa and Brazil, leading to further outsourcing of police work (United Nations, 2007; Wakefield & Button, 2014). For a time, the UK was encountering a new wave of privatization of police functions until a shift in public sentiment. Following the government's declaration in 2010 that police funding would see a reduction of 20 percent by 2014–2015, West Midlands and Surrey police invited bids for the largest ever police outsourcing contract at a value of £1.5 billion (Guardian, 2012a), inciting speculation of police work and its possible future. Surrey suspended its initiative a few months later as a response to concerns over G4S, the world's largest security company, which failed to meet the terms of its substantial contract to provide the security officers for the London Olympics, in terms of the numbers as well as the quality of personnel (Guardian, 2012b). West Midlands also went back on their plans facing political pushback.

As such, these kinds of issues with privatization may impede police measures at least in the short term, but as demand for private services grows, de facto privatisation in the future appears a possibility. Technological advancement drives a security industry that is constantly developing innovative, more sophisticated, cost-effective technologies. It is a trend associated with rebounds in construction and capital investment spending, perceived high risks of crime, and improvements to security technology with an underlying shift from manned security towards automated security functions (Freedonia, 2012). Policing has become increasingly technology intensive as opposed to labour-intensive (Shearing & Stenning, 2012) and private security has, for a while, taken advantage of the police through its access to technological resources (Shearing & Stenning, 1983).

Therefore, if privatization and mechanisation are expected consequences of fiscal austerity, and the UK has experienced such measures for the past decade, questions arise on the effects of such measures on the quality of the service provided in forensic science and crime scene practice, and the role of the private sector in quality control, assurance and the potential automation of policing in order to lower costs. The failsafe measures for ensuring quality of forensic services is a critical consideration when factoring in its effects on the entire criminal justice system. Diminishing investment, and lower numbers may paint a concerning picture for

the future, and as such, the state of forensic science and its integrity-maintenance mechanisms become all the more important for consideration. These matters will be examined in detail, in the ensuing chapters.

CHAPTER SIX

In the previous chapter, the roles and responsibilities of crime scene practitioners was examined, using the role profiles provided by police forces in England & Wales, Scotland and Northern Ireland. In addition, investment and numbers of scene staff were also assessed. Using the data, the differences between crime scene investigators, examiners, and scenes of crime officers, and the boundaries of their work was explored. One of the striking findings was the seemingly low bar for entry into the practice of crime scene work. Recruitment notices and advertisements were found to merely seek interested parties with little or even no experience with the caveat that they undertake training for less than a year to be integrated into the scientific support structures of the respective hiring organisations. Residential courses, and completion of the National Training Centre Scenes of Crime Courses was cited as minimal requirements, while there was mention of appropriate internal and external scientific examination courses (force-specific), OIS and CIS (stated as, if appropriate), GRS, H&S induction, and the SOCRATES Forensic Management (computer) System. There was also mention of module 1 and portfolio, and module 2 of the National Crime Scene Investigation course, or National Policing Improvement Agency conversion course, but no other undergraduate or postgraduate academic requirement was sought by the forces.

This could potentially be seen as an alarming characteristic of crime scene work in the UK, unless it could be offset by some mechanism which ensured that services provided by these practitioners was up to standard. It has long been understood that quality service, regardless of sector or level is dependent on the quality of those providing it (Ghobadian et al. 1994). Any work that could possibly lead to the loss of liberty, or even a worse consequence for a member of society would need to be accurate with sufficient quality control. The need for checks and balances is deeply rooted in a citizen's constitutional, and statutory human rights of due process, which does not only extend to the accused, but also the victim. Inquiries into the mechanisms of quality assurance, control, validation, certification, accreditation and standards in crime scene work, as well as how practitioners are regulated, are vital avenues for examination in the sociological sphere.

As the role profiles did not have any educational requirements of a scientific nature or otherwise, any quality assurance (QA) discussion would require an understanding of what it actually means in crime scene contexts. Commentators have been known to advocate for scene investigation to be driven by use of the scientific method (Shaler, 2011; Gardner, 2011; Houck et al. 2017), but this is not a requirement specifically sought in the studied role profiles. This chapter will therefore need to comprehensively evaluate the quality control and quality assurance practices in forensic science, and crime scene practice with particular emphasis on

the scientific method, examining the importance of the latter in scene work, and whether a shift in understanding and practice is warranted to advance the discipline and its practitioners.

Quality Assurance, Credibility and Societal Trust

Credibility and trust are essential by-products of a robust quality assurance mechanism. Trust is understood to be an expectation on organisations, individuals and their discretion (Svensson, 2006). Trusting individuals concerns what has been referred to as 'face-work' commitments, where another's honesty and probity are sought after (Giddens, 1990: 80). It relates to the conduct of professional actors, such as scene practitioners and their personal and direct relation to customers (law enforcement, the courts and society as a whole) representing the access points of abstract systems or social institutions. It is complemented by impersonal confidence — the expectation and the likelihood of those institutions and its actors to use rules, routines and role expectations. Confidence in such abstract systems is a type of faceless commitment which relies on the fulfilment of professional knowledge roles and expertise (Giddens, 1990). Applied to institutions, such as law enforcement, confidence can often be based on characteristics that are ascribed to them by reputation or indirect sources, without personal experience from an interaction or exchange process at, for example, access points to abstract systems (Kramer & Tyler, 1996: 18; Giddens, 1990: 83). The quality of scene work and associated crime scene service is thus a matter of reputation and of public confidence in the state mechanisms of law and order.

Research from Ipsos MORI (2014) found that two in three (65%) Britons stated they would generally trust the police to tell the truth, while 31% did not trust them to do so. It was also found that over a ten-year period between 2004 and 2014, despite a steady increase in 'happiness' with police service at the point of contact until 2013, 2014 saw a steep fall to similar figures to 2004 (IPCC, 2014). The same study found that 74% of survey participants were open to making an official complaint if officers failed to properly investigate volume crimes. Trust was higher among the young than the old (73% of 18-34s said that they trusted police to tell the truth, compared to 59% of those aged 55+) and by women more than men (68% to 62%). The figures reflected not only trust and confidence in the police organisation, but the policing mechanism, of which, forensic science is a key part.

It has been argued that competence in fulfilling occupational duties is strongly related to confidence in abstract systems and institutions as well as trust in individual professional practitioners. It is emphasised by modernization's fewer traditional links and individuals' increased personal responsibility (Evetts, 2006). The concepts of confidence and trust are complex and can be solidified and put into practice in a myriad of ways. Professionalism also has strong links to different types and perceptions of knowledge and competence. It requires

practitioners to be worthy of that trust, to maintain confidentiality and conceal knowledge by not exploiting it for malign purposes (Evetts, 2003).

Discourses on knowledge societies and organizations, along with marketization and management, enforce demands for professional competence. The management of autonomous professional work through formal credentials before entry into employment is supplemented by recruitment with, and socialization into, certain values and attitudes according to organizational cultures. Findings from the previous chapter would weaken arguments about the value associated with scene practitioners, especially due to the low-bar set for entry. However, without addressing the mechanisms of quality assurance and development within the occupation, it would be premature to question their legitimacy as fact-finders within state law enforcement infrastructures. The maintenance of legitimacy is regarded in much of social science as the most efficient way of reproducing social order and social cohesion (Weber, [1920]1978: Part III). Legitimacy is closely allied to the concepts of trust and confidence, which have been related to social capital (Luhmann, 1979; Ostrom, 1990; Coleman, 1990; Putnam, 1993; Misztal, 1996; Lin, 2001).

Professional issues are therefore a discourse of occupational change and control and it assists in understanding issues of trust and professionalism (Evetts, 2003). The most important effect is to link the field of occupational groups more closely with the sociologies of work, occupations and organizations, which draws attention to the issues of trust, competence and professionalism. It also sheds light on the expansion of target-setting and accountability, and whether competencies are becoming less reliable in post-modernity (Dear, 2001).

The notions of trust and competence are interconnected having continued to be part of popular discourse, especially medical, legal and criminal justice practice (Evetts, 2006). ‘Can we trust our public services or the people who work in them? It seems that increasingly doctors, lawyers, scientists and many others are treated with suspicion. The words of politicians and businesspeople are doubted, and their motives questioned’ (p. 516). Such questions are argued to be consequential for the research field of sociology of professional groups (p. 526).

Importance of Demarcating Boundaries

There are other equally persuasive reasons for examining quality assurance systems and professional issues in crime scene work. Boundary-work, a means of identifying actors within organisations through their roles and responsibilities is especially useful to understand occupational dynamics of groups otherwise difficult to study (Gieryn, 1983). Such sociological enquires can also assist in assigning proper labels to individuals or groups (Hall, 2005). Demarcating boundaries can inform as to the limits of occupational roles and responsibilities, which often either overestimates their involvement in critical tasks which may not be part of

their employment responsibilities or excludes them from fulfilling those duties that are expected of them.

Boundary work becomes relevant and useful in contextualizing crime scene practice in the wider forensic sciences by tracing the differences in the way quality assurance and control applies to their practice, and by extension, them. With technical evidence becoming an increasingly valuable commodity in legal controversies, legal practitioners and their clients are becoming acutely conscious of the value of forensic knowledge, if it can be effectively presented as the truth, or the best approximation of it. The neo-liberalization of the forensic science market (Lawless & Williams, 2010) has accentuated the need for a greater understanding of the dynamics of the interaction between public and private forensic support services, their cooperation schemes, and the distribution of individual roles and responsibilities. Quality assurance and control provide a useful framework to understand these roles and the increasingly fading line between public and private enterprises. Public confidence is deeply rooted, as seen above, in the efficient performance of duties by state authorities and those employed by the same. Quality assurance in forensic science, and crime scene practice is therefore a cogent indicator of state and private sector mechanisms to protect society and its members from unjust arrests and wrongful convictions. The concepts of QA and QC therefore require careful attention and formulation in order to inform and drive discussion forward concerning the health of the criminal justice system, whether existing systems can be trusted or require change.

Quality Assurance and Control in Forensic Science

Quality assurance is generally agreed as vital to the forensic sciences, with measurement of quality a matter of paramount importance (NAS, 2009a; Malkoc & Neuteboom, 2007; Jasanoff, 1995). Such systems are most-often laboratory-based. However, commentators argue that any quality control system must extend outside the laboratory environment and should put responsibility on all involved in an investigation to maintain a chain of custody (Giannelli, 2007). A more appropriate expression would be a chain of integrity as the court will need to know not only the identity of the links in the evidential chain but also the actions and inactions of individual or group actors involved in its collection, processing, transportation, and analysis. Keeping track of the identity of the handlers of evidence at each stage will serve to assure the court of the awareness of the consequences of any deficiency in the many processes that the evidence can undergo during an investigation. The chain of custody of the physical and biological evidence is thus integral to preserve the integrity of forensic work and the evidence (Fish et al. 2013).

Another method suggested for quality assurance has been adopting a conceptual understanding of the scientific endeavour and the forms of knowledge essential to producing robust scene reconstructions. Studies have revealed that different forms of knowledge and expertise determine the quality of the service provided in the forensic sphere (Köpsén & Nyström, 2015). Doak & Assimakopoulos (2010) demonstrated that to undertake work as per standard procedures in a forensic laboratory setting, required the interaction of individuals and the sharing of expertise and advice, in what can be described as a collaborative model. Shaler (2011) and Millen (2008) found a similarly interactive and collaborative trend in crime scene examination. Crime scene work is thus usually restricted to trained personnel with occasional assistance from laboratory-based scientists. All involved are tasked with safeguarding the evidential artefacts from deterioration and contamination. The latter is of vital importance when suspects have been arrested, as the risk of contamination, and/or confirmatory bias considerably increases under these circumstances. Aside from this, quality assurance systems within laboratory setups and field disciplines, such as crime scene examination have little similarity (Roux et al. 2012).

To ensure the quality of reported results, police forensic laboratories usually adopt an established quality assurance program (Christensen et al. 2014), but they are not compelled to do so (Garrett & Neufeld, 2009). These, when diligently maintained, are intended to ensure that such results are scientifically valid, and that opinions stem from observations and analytical data that are trustworthy and reliable. An established QA program places requirements that must be adhered to by all personnel, including lab management, technicians, and casework staff (Levy et al. 1999). Requirements will generally include an organizational framework that is appropriate for the activities undertaken, where educated and trained staff can work, at facilities that are appropriate, including laboratory, office, and storage areas (with adequate security and access control), with fit-for-purpose equipment that is regularly maintained and calibrated (Gough, 1997). Case file and exhibit management systems are in place, with documented methods and procedures (to cover both administrative and technical activities). Regular audits, quality control (QC) tests, and staff proficiency testing for the continuous monitoring and assessment of performance are expected to be present. Routine peer review of case files, results, and reports further augment quality assurance efforts.

QA systems are also expected to adopt a philosophy of continuous development and improvement while heeding to customer/end-user needs. Forensic science facilities will generally have law enforcement as their service end-users/customers. The courts, and ultimately the general community are also beneficiaries of their work. It must be clarified that customer requirements do not imply that forensic science practitioners are only tasked with giving law enforcement the analytical results that they need to implicate a suspect. Their job is

to provide objective, scientifically reliable services that is on time, ensuring that the evidence gathered, and results generated can withstand the most rigorous scrutiny in court (Brunelle et al. 1982).

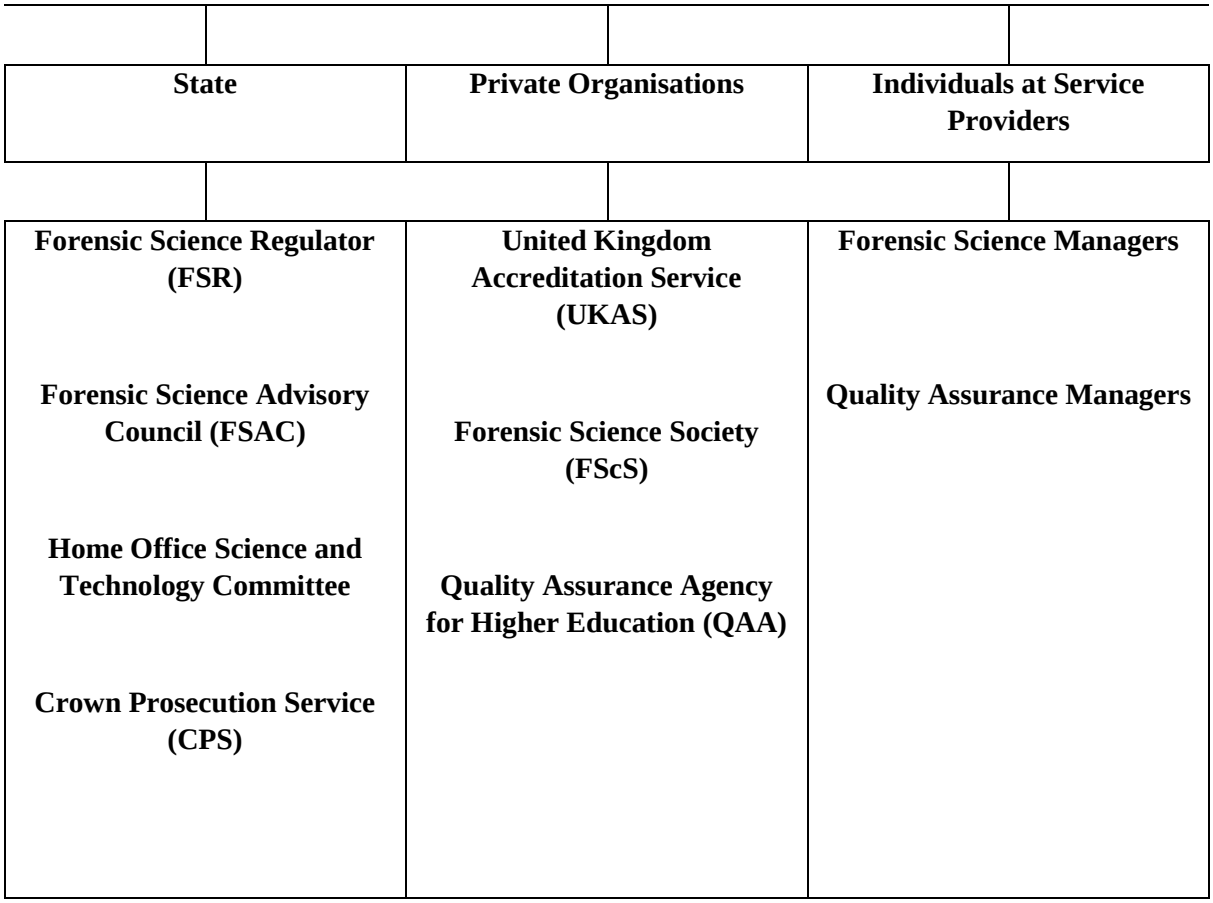
Quality is often described as the extent to which a service meets a defined set of prerequisites (Lentini, 2009). In laboratory environments, QA describes the general measures used to safeguard the quality of its operations and the reliability of reported results (Jackson & Jackson, 2011). Quality Control (QC) relates to the operational techniques and activities that are employed to fulfil the requirements for quality. They are the procedures implemented by laboratory personnel for the continuous monitoring of procedures and analytical results to verify whether the results are adequately reliable for release to the end-user or client (White, 2010). QC is therefore a key element of QA, aimed at ensuring the quality of test results reported for individual samples or sample batches.

Laboratories often set up QA programs that address defined prerequisites outlined by an international standard or a relevant external accreditation body. Upon establishment of the QA program, labs may seek formal accreditation with an external body. It is generally accepted that accreditation by an external agency constitutes independent verification that the QA regimes in place fulfil the management and technical requirements of the relevant international standard and/or requirements set out by the accreditation body. Formal laboratory accreditation does not guarantee the quality of reported results, however. The best it can do is provide a sound basis for achieving the desired outcomes of the accreditation-seeking organisation (Tilley & Townsley, 2009).

The QC and QA mechanisms for crime scene practice is however more complicated than laboratory settings. The fundamental pillars of ensuring quality in forensic science, such as standardisation, certification, and accreditation are not enforced across the board in crime scene work. Instead, examiners are expected to adhere to standards through a process of training, observation, and human oversight, with recent emphasis on the adherence of staff to the scientific method to ensure objectivity and quality service. There are understandable reasons behind this particular emphasis on human oversight, in the absence of systematic alternatives. However, any standards would require codification, distribution, and an effective system of monitoring and enforcement which has been a major challenge in jurisdictions across the board, especially the UK.

Diagram 6.1

Quality Assurance Stakeholders in the United Kingdom



Role of State Quality Enforcement Bodies in the United Kingdom

At the time of writing, the Forensic Science Regulator (FSR) is all that remains from a framework of quality assurance organisations, which closed its doors one-by-one since 2008, leaving the former alone as the state-funded quality assurance provider (NAO, 2014). The Forensic Science Regulator (FSR) is a public appointee, who is funded by the Home Office, but independent of it (Wilson et al. 2014). The FSR makes sure that there is an appropriate system of quality standards under which forensic science services function. This is done in collaboration with the relevant authorities in Scotland and Northern Ireland. The FSR outlines its expectations of all forensic science service providers in the Codes of Practice and Conduct for forensic science providers and practitioners in the Criminal Justice System (Samuels, 2014). These expectations apply across the board to providers in the private and public sectors, including law enforcement, although the FSR does not have statutory powers to enforce them (McCartney & Amoako, 2019).

Prior to the inception of the FSR, the Forensic Science Service (FSS) was wound up by the Home Office in 2012 after data emerged that it was losing £2m a month during its operation (BBC, 2013). The closure cost the government £95m and made 1600 people redundant. Another QA organisation, the Council for the Registration of Forensic Practitioners (CRFP) was set up in 1999 after a series of high-profile miscarriages of justice, such as the Guildford Four and Birmingham Six cases (Edmond, 2002). It was responsible for accrediting forensic science professionals, and ensuring competence and quality standards, but also closed its doors in 2009, after the Home Office and National Policing Improvement Agency pulled the £500,000 annual operational cost of the organisation. The role of the FSR has also been questioned (BBC, 2015a). There are serious doubts over the effectiveness of Home Office oversight, and the FSR's lack of compellability in data collection, and lack of statutory powers to enforce compliance of standards (NAO, 2014). Indications are that the state is placing a large burden on the private sector, and management staff at forensic service providers, to ensure quality. One such body is the United Kingdom Accreditation Service (UKAS), which is the sole national accreditation body recognised by the British government to assess the competence of organisations that provide certification, testing, inspection and calibration services (UKAS, 2019).

The Role of United Kingdom Accreditation Service (UKAS)

The requirement of standards for crime scene investigation has been accentuated by the NAS (2009) in the U.S. and the FSR (2015) in the UK. In the latter, attempts have been made to provide accreditation to organisations by several bodies, including the Association of Chief Police Officers (ACPO), National Police Improvement Agency (NPIA), Skills for Justice (SfJ), Council for the Registration of Forensic Practitioners (CRFP) and the Forensic Science Regulator (FSR). The United Kingdom Accreditation Service (UKAS) has been at the centre of a push to provide accreditation to forensic laboratories, and in 2012 it accredited Orchid Cellmark Ltd (a private forensic science service provider) in crime scene investigation (UKAS, 2012).

UKAS used ISO/IEC 17020 as a basis for their accreditation for the examination of crime scenes and credited a robust and demanding pilot scheme in becoming among 'a handful of accreditation bodies throughout the world who now offer accreditation for crime scene examination' (UKAS, 2012). In an overview, UKAS (2013) cited ISO/IEC 17020 as an appropriate standard for the scope of crime scene work undertaken by individual practitioners. The explanation carried guidance on 'inspection bodies' ability to be accredited by carrying out competent, independent and impartial inspections and provide their client(s) with information/evidence relative to conformity with regulations, standards or other specifications

(p.2). Under the guidance, accredited inspection bodies must demonstrate the competence of personnel for all functions. The minimum requirements for competence have to be defined by the inspection body but are driven by 'industry' norms and where, for example, existing training and occupational skills requirements can be recognised as contributing to the necessary competence (p.2). However, it provided no specific guidance on crime scene investigation or its practitioners, instead deferring to 'EA-5/03 Guidance for the Implementation of ISO/IEC 17020 in the Field of Crime Scene Investigation' (ENFSI & EA, 2008) and 'IAF/ILAC-A4:2004 Guidance on the Application of ISO/IEC 17020' [withdrawn] now 'Application of ISO/IEC 17020:2012 for the Accreditation of Inspection Bodies' (ILAC, 2012).

UKAS was also found to be responsible for the accreditation of courses recognised by police forces in England & Wales, in the role profiles examined in the previous chapter. The College of Policing specifically cites the same on their web site when referring to quality of the courses offered under the CSI Level 1, and CSI Level 2 banners (College of Policing, 2017). West Yorkshire Police and Humberside, in their FOIL responses, added a further dynamic about the involvement of CSIs in DNA analysis. As part of the response letter, to the question of the overall laboratory spending on forensic science, they responded: 'The CSIs would previously have carried out basic DNA recovery of seized property but new regulations dictate that this must now be carried out in a UKAS 17025 accredited facility…'.

ISO/IEC 17025 and ISO/IEC 17020 contain similar management system requirements based on ISO 9001:2008 (section 4 in ISO/IEC 17025 and clause 8 in ISO/IEC 17020). Beyond these requirements, the standards are separate. ISO/IEC 17025 requirements concern measurement uncertainty, traceability, and analytical validation. ISO/IEC 17020 requirements, in contrast, focus more strongly on impartiality, independence, and confidentiality. UKAS' approach of relying on ISO/IEC 17020 has its own set of issues, however, one which relies heavily on undefined parameters and overreliance on the private sector for guidance.

The public/private discussion is pertinent on account of the Conservative government's history of neo-liberalisation of criminal justice and redistribution of justice system labour, most notably 2014's Transforming Rehabilitation reforms which led to the restructuring of probation services in England and Wales (Robinson et al. 2015). Sociologically, privatisation can be components of a wider evolving process in which the state's traditional responsibility and presumed capacity to act as primary provider of safety and security to its population is challenged (Caparini, 2006). This shift can be attributed to the gradual move from government to governance, or the diffusion or fragmentation of political authority among various public and private actors at the local, state and international levels (Hänggi, 2005). Such pluralisation of security can lead to multiple types of authorisers and providers of security that includes public

bodies and institutions, non-state (private) actors and hybrid or mixed forms with an amalgamation of the two (Bayley & Shearing, 2000). The extent of privatisation and private sector involvement in crime scene practice has not been particularly evident from the available literature, and this requires further examination to understand any shifts and their dynamics in the public/private divide.

Private Sector and Regional Bodies in Forensic Science Quality Assurance

Private forensic science providers occupy a significant part of the UK scientific support services market (Lawless & Williams, 2010; Lawless, 2011). The neo-liberalisation trend is also evident in the quality assurance business. Skills for Justice (UK), the organisation that lends its definition of competence to the FSR for publication, state on their web site, that they support organisations in meeting ISO 17025 and ISO 17020 training and competence requirements. It is part of the Quality Standards Specialist Group, a collective to aid the FSR in formulating quality assurance standards in forensic science.

Since the late 2000s, the European Network of Forensic Science Institutes (ENFSI) and European Co-operation for Accreditation (EA) devised strategies for crime scene investigation, with a view to introducing new quality paradigms, following revelations of the limitations of ISO-17025 (general requirements for the competence of testing and calibration laboratories), when applied to scene work. The limitations were found to be somewhat addressed by applying the ISO-17020 (general criteria for the operation of various types and bodies performing inspection) quality standard. The operative question pertaining to the standard to be adopted for scene of crime work was which one of the two worked better for forensics purposes. The ENFSI Working Group Scene of Crime found that the guidance for the accreditation of crime scene investigation concerns the forensic competence at the scene of crime, rather than just the equipment used. This is not particularly helpful in understanding the meaning of competence and what conduct would suffice in fulfilling the standard.

Every crime scene is different; however, fundamental steps must be followed to ensure that the integrity of the physical evidence is not compromised (NFSTC, 2013). These steps are however, 'moderately uniform' (Smith et al. 2005: 83) as methods and techniques are not standardised (Mennell & Shaw, 2006). For the purposes of analysis, a middle ground between reliable guides to crime scene investigation must be reached. Many law enforcement agencies in the U.S. have adopted the Federal Bureau of Investigation's 12-step process (FBI, 2000) to gather and protect evidence at the crime scene (Fish et al. 2013), and in the UK, the Association of Chief Police Officers (ACPO)-issued Murder Investigation Manual (ACPO, 2006) provides a useful guide. Procedural guides are helpful because, by following the standardized process at

every type of crime scene, the crime scene practitioner may be assured that every step is performed methodically, which simplifies court testimony.

While each of these guides add definitions and scope to crime scene work and lays out principles for personnel roles and often quality standards, they rely on adoption of existing ISO standards rather than formulating new ones. The most widely used of such classifications are the ENFSI and EA guidelines, which cover a variety of crime-scene-specific facets, and also illustrate the issues plaguing the discipline in its search for robust and well-implemented quality regimes.

ENFSI Definitions and ISO Standards

The European Network of Forensic Science Institutes (ENFSI) which approached the European Cooperation for Accreditation (EA) justified the use of ISO/IEC 17020 in ENFSI & EA (2008) stating that a great deal of professional judgement is applied in the investigation of crime scenes where the investigators have to use professional judgement based not only on observations made at the scene but also on previous experiences. In their view, this made it 'very natural' that this particular standard be used as the base for crime scene investigations (p.5). As a base document, 'Guidance on Assessment in the Field of Forensic Evidence Recovery' prepared by Swiss Accreditation Service (2005) was used.

ENFSI & EA (2008) defined a crime scene as a scene of incident prior to establishing whether a criminal or illegal action has taken place or not and is not solely restricted to the location of the incident, but also includes areas where relevant acts were carried out before or after the crime (p.8, clause 2.3).

They also defined the term 'Investigator' to include persons, however named, trained to perform crime scene examinations and/or investigations, with such names as Scene of Crime Officer (SOCO), Crime Scene investigator, Crime Scene Examiner, etc. It is said to denote persons performing the function of 'inspector' as used in ISO/IEC 17020 (p.8, clause 2.9). Inspector competence is also mentioned in previous documentation (UKAS, 2009).

Commentators have stressed however, that ISO 17020 is a conformity assessment standard for bodies performing inspections, and that forensic science is not a conformity assessment as each accreditation decision is subjective and dependent on examiner interpretation, rather than based on a fit-for-all, objective standard (NIST, 2017). The accreditation bodies (like UKAS) via ILAC made determinations for the forensic science community without proper consideration to the appropriate basis (fitness for purpose) for forensic science body accreditations, (ILAC-G19:08/2014). It was further stressed that ISO/IEC 17020 refers to the crime scene/examination process without further addressing the analysis of the findings (NIST, 2017). This would lend

the argument that in order for a more complete and comprehensive understanding of quality in scene contexts, further examination would be required beyond ISO/IEC literature.

There are common threads that run through the understanding of the purported best quality practices in crime scene work which could shed light on the matter. Pfefferli (2010) summarised that the quality interface with general police crime scene work is an important consideration, in that, it still stands that the first responder to any crime scene is rarely the trained scene practitioner and that they can only arrive at a scene once a value judgment is made by a non-expert, that an area is a potential crime scene. Commonly defined quality refinements in crime scene work are still not universally agreed upon, and if stakeholders are to agree that the interface of police–science at the scene of crime is neither self-explaining nor self-regulating, how are examiners to address any joint and/or combined quality policy? Validation and traceability are still matters of critical importance, where there is a full spectrum of crime scene methods to be handled by crime scene specialists, and only a few that readily meet the requirements of validation and traceability, especially those defined by common accreditation standards. These are evident difficulties, and the ISO 17020 standards provide little or no recourse on these matters. But ISO certification is only one of the criteria to determine quality control (Houston Forensic Science Center, 2014), with standardisation and accreditation being the others (Lentini, 2009).

This is illustrated in the following table:

Diagram 6.2

Quality Assurance in Forensic Practice

Accreditation	**Certification**	**Standardisation**

The lack of enforceability of forensic science quality assurance policies is also not counteracted by lawyers and judges at the trial stage, by delving deep into the operational practices of those testifying practitioners, largely due to the former being seldom concerned with quality assurance, and more with the validity of new scientific techniques (Levy et al. 1999). The Forensic Science Regulator's attempts in the UK to bring quality managers together in conferences since March 2013 (FSR, 2013) can be lauded, but does not address the enforceability dilemma, either on an organisational or national level. The ENFSI 2012 Scenes of Crime Best Practice Manual is still listed on the UK College of Policing web site, as a useful resource in quality assurance in crime scene work, despite the document's removal from

ENFSI's own web site, leading to an inference that ENFSI may be working on an updated document.

There are other challenges, specifically with regard to a misunderstanding of performance indicators, meaning and scope of competence in scene work, and the manner in which objectivity in scene work can be ensured. These seldom-examined matters require further review, because identification and evaluation of these obstacles can lead to formulation of possible solutions, that hold policy implications.

Challenges to Quality Assurance in Crime Scene Practice

Operational principles and procedures for many forensic science disciplines not being standardized or embraced, either between or within even similar or same jurisdictions (NAS, 2009a). And, as standard methods and practices are an integral part of any quality-assurance system (ISO 17025-2005: 13), this fragmentation is a cause for concern. There is also no uniformity in the certification of forensic practitioners, or in the accreditation of crime laboratories both in the UK (Jackson & Jackson, 2011) or the U.S. (NAS, 2009b). Most jurisdictions do not require forensic practitioners to be certified, and the majority of forensic science disciplines have no mandatory certification programs (NAS, 2009a; Home Office, 2013). Additionally, codes of practice (FSR, 2011), quality assurance guidelines (QAA, 2012), operational guidance (FSR, 2015) and, accreditation and certification protocols (House of Commons, 2013) are not enforceable in the UK by the Forensic Science Regulator (Home Office, 2013) with the same limitations present in America's federal authorities (FBI, 2000; NAS, 2009a).

Historically, forensic practitioners particularly in crime scene work, resisted the idea of standardization of methods and practices because 'every case is different', or 'samples are too small and not homogeneous' (Lentini, 2009). However, forensic science stakeholders need to be assured that the discipline is following standard methodology, so that the stakeholders have a way of judging whether the forensic science results are accurate, reliable, or meaningful in the context of the case they are dealing with, and to minimise potential bias and sources of human error in forensic practice (Kaye, 2009). And, as calls for structural reform in both jurisdictions echo in the scientific and criminal justice spheres (House of Commons, 2013; NAS, 2009a), the need for research into the mechanisms by which state guidance, rules, and procedural codes are taught by forensics educators, adopted by practitioners, and enforced by forensic science managers, becomes all the more relevant.

The issue is compounded by a general lack of understanding of what competence in forensic science, especially crime scene work involves (Tully, 2018). The prevalent understanding of the effect of the limitations of conceptualising competence is stifled by the noticeable absence

of research that addresses questions about how "competent crime scene examination" is defined and the ways in which CSEs use their "repertoire of observational skills, manual competences, logical inferences, technical understandings, and other forms of situated practice" in investigations to fulfil their duties (Williams 2004: 3). There is considerable variation in how CSEs are used in different forces, as well as wide-ranging difference between examiners themselves in how they undertake their occupational tasks and the value of the information extracted from their work (Williams, 2004). Ribaux et al. (2010: 67) suggested that crime scene work at volume crime investigations centre on "greater variety of, often tacit, strategies and practices" compared to major crime investigations.

Williams (2004) found that the law enforcement organisations with a high level of CSE resources per crime predominantly followed the technical assistant model (limited role as providers of technical knowledge to investigators), while forces with lower resource levels had to use better systems of "enhancement and monitoring" and were associated with the expert collaborator model (working as associates and pooling expertise to reach common goals). The indications appear to be that there may be some correlation between the individual workload, the level of demand, and the local crime rate. These may determine how crime scene examiners are perceived and how they are utilised by their employing organisations. CSEs who are described as knowledgeable, well informed, and respected have been found to be better utilized in criminal investigations (ACPO & FSS, 1996; Williams, 2004). The perception of others however can influence the role of scene examiners, and conditions their conduct. CSEs are expected to cooperate and work as a unit with specialist personnel from police and other agencies, as well as multiple specialist suppliers (SPSA, 2010). The role of positive relationships, mutual respect, and understanding of the expertise of each member of the team can lead to a more effective and efficient investigation.

The performance pointers for scene examiners have historically focused on such aspects as the number of scenes attended, the number of items collected and submitted, and much less on the value of the evidence, how the evidence furthered the investigation, or the overall investigative outcomes (Tilley & Ford, 1996; Williams, 2004; Adderley et al. 2007; Scientific Work Improvement Model, 2007). Information is difficult to gather on how forensic evidence is used in investigations and in turn, how scene investigation affects investigations, in general. The value of evidence and absence of feedback on the outcomes of investigations to crime scene examiners, contribute low incentives for examiners to be more proactive in investigations beyond the stage of evidence collection (Morgan, 2017). Lack of understanding, and often misconceptions of the contribution of scene examiners therefore can be a barrier to utilising the skills and abilities of practitioners who may not be aware of the boundaries of their occupations, or the organisational limits of their involvement in investigations.

Misconceptions About Objectivity in Scene Work

Quality control in scene investigations can thus be argued to depend on the quality of the investigator's capacity to make sense of evidential artefacts. It can tie in directly with the ability of these individuals to think critically, formulate hypothesis and adhere to the scientific method. As such, scene investigators are more inclined to belong to the professional model of organisational practice, despite there being little to no evidence of them sharing other characteristics which would elevate them individually or collectively to professionals.

There is a belief among scene investigators that their work is a critical process and, as such, they often take it upon themselves to process scenes and collect evidence to support a successful prosecution (Ludwig et al. 2012). This may often lead to suggestions that their work may not be entirely objective, as their primary goal could be said to assist the state build a case against whoever may have perpetrated the offence. It could lead to accusations that scene examiners do not actively seek or report exculpatory evidence that could potentially eliminate or exonerate a suspect. However, this can be easily refuted if the collection process is objective, and the constant that goes through their work is the scientific method. Scene investigators mostly represent the investigative wing of law enforcement and, thus, are an integral part of the prosecution case-building mechanism. Many argue that their undertaking is to locate probative evidence to prove that an individual or group committed an offence, despite undertaking the task through a process of deductive reasoning — where, if their suppositions are true, the conclusions are also taken to be true. Despite instances of misconduct and subpar work, it is important to note that often these could be merely apprehensions rather than issues grounded in actuality. Such apprehensions require further examination, though, especially as a reminder of the possible misconduct and/or biases that may compromise an investigation or crime scene endeavour.

Theoretical Biases and Tangible Misconduct

Conceptually, it can be argued that scene examiners are just as biased as the forensic experts hired by the defence team. The prosecutor, arguably the most critical member of the prosecution's adversarial team, is by definition also biased in that regard. But it can also be argued that the prosecutor, being an advocate in an adversarial system, is supposed to be biased. Scene investigators who respond to the scene and who are likely employed by law enforcement are required to resist these apparent biases as they have no personal stake in the investigative process or its outcome. Science has the ability to objectively drive the investigative process, and this is the quality of the scientific method that should prevent biases, errors or misconduct. These must be separated from any theoretical biases that could exist as a mere by-product of scene practitioners working for the state law enforcement apparatus.

Grounded instances of misconduct are however well reported in scene work, especially in the US. The following instances of impropriety has been found, and is documented in jurisdictions across the board (Turvey, 2013):

- Planting evidence at a crime scene to implicate to a specific individual or group
- Collecting evidence without a warrant by claiming exigent circumstances
- Ignoring evidence at a scene that has the potential to exonerate an individual or group
- Failing to report a colleague, superior, or subordinate for inappropriate activity

It can be argued that to achieve objectivity, one method can be to consider each scene investigation as a research project. At crime scenes, investigators will work at the outer edges of the unknown and uncertainty — meaning, they start with a blank slate, free from any pre-existing suppositions or biases. Unlike scientific research, though, there is no fall-back position and rarely peer review. In fact, most criminal cases have no contemporary review process, no peer review, and thus no mechanism to uncover subpar, biased, or fraudulent work. The scientific process is the antithesis of what happens in real-life crime scene investigations, despite such a tacit importance being placed on the scientific method.

In the previous chapter, it was found that role profiles in UK police forces make no explicit or tacit calls for scene practitioners to employ the scientific method in their work. The recruitment criteria does not require any degree in the hard sciences, and training requirements are limited in scope with emphasis in experience building and have an open-mind being a staple. Commentary on the subject can however fill in some of the gaps, especially to illustrate the problematic reliance on human oversight as a QC measure in crime scene work.

Excess Burden on Quality Control Managers

The general quality assurance strategy, however identifies quality control managers being at the heart of ensuring that certification of the laboratory is maintained, and that the work is done, and to cease casework in order to investigate and/or address a quality issue arising in any of the analytical sections of the laboratory (FSR, 2013). However, the established means of quality control, and assurance in laboratory settings is markedly different from crime scene practice. The mechanisms for maintaining and ensuring quality in forensic laboratories can be divided into a number of quality assurance subdivisions, such as qualification and training, equipment and instrumentation, measurement standards, standard operating procedures, validated methods, technical documentation and reporting, and effective methods of quality control.

Diagram 6.3

The basic organisational structure of crime scene practice in police forces in England & Wales
Regional Force Operations Manager
CSI Manager
CSI Supervisor
CSIs, Volume CSI

There is often debate between the exact role of crime scene managers (Williams, 2004; Millen, 2008). It is generally understood that they will be responsible for the efficient investigation of crime scenes and facilitate the flow of information between the relevant past stakeholders in the investigation (Pepper, 2010). Crime scene managers are a lot more than man managers focused on evidence collection and information exchange. The first action of crime scene personnel is often confirming that all possible steps to preserve life had taken place. This would be in coordination with first responding officers and those already present at the scene, and the emergency medical personnel on site, or en route. Regardless of appearances, only trained medical personnel could confirm death, and until that, all personnel usually would assume that the person before them was alive and in need of medical assistance.

Initial cordons would be set up by first responding officers, but it is the responsibility of the crime scene manager to review, revise and confirm the cordon, and in some instances even extend it. It is often cited that a larger cordon is advisable, as it can be reduced later (White, 2010). Extending cordons, though difficult is not impossible. The risk is that evidence outside of the cordoned area, could be contaminated after the initial boundaries are put up.

Detailed logs are kept as to who enters and leaves the scene, with the relevant date and time (Fisher & Fisher, 2003). While internal scene security, that is within the cordon is the responsibility of the crime scene personnel, the outer area and protection of the crime scene as a whole falls upon police officers who limit access to only those with cause to be there (Gardner, 2011). Access requests and determinations regarding entry and exit rest on the crime scene manager. Evaluations are also made on the impact of individuals entering and leaving the scene before the crime scene team arrived, and/or cordons were put up. The scene manager would usually speak to those members, and decide whether they could have contaminated the scene, or inadvertently transferred evidence on to their bodies, or clothes. If such is determined, then the clothing, footwear and/or equipment used by the staff members would require collection, and examination as elimination samples.

Initial activity at a crime scene involves listening, assessing the nature of the allegation/activity and evaluation of the needs of the investigation in accordance with the resources available (Lewis, 2015). Resources would cover not just personnel, but the equipment and time available to effectively process the scene and recover the maximum amount of relevant evidence. In situations where trained scene personnel are not available, clear and specific instructions are given to police personnel on the steps to be taken for the preservation of the scene and the evidence it contains, until a scene investigator becomes available to attend.

While crime scene investigators are autonomous in their decision-making, scene managers coordinate the wider strategy to be taken (White, 2010). There is often no standard operating procedure on how to begin an investigation at the scene. Managers assess the scenario and make a determination as to the best course of action for that particular scene. Depending on the case, managers also identify the appropriate type of search strategy, and the personnel required for that particular strategy.

Initial assessments usually include consideration of any hazards or dangers which might affect the investigators and/or the specialists at the scene (Bucholtz et al. 2010). Good practice is understood to be planning for these contingencies and including strategies in briefings given to the team. Along with the proper information, the right protective clothing and equipment are determined. Due to the dynamic nature of crime scenes, conditions are susceptible to change, such as weather or lighting for outside scenes. Crime scene managers take into account these changeable conditions and prioritize examinations accordingly.

Scene managers are in constant contact with the senior investigating officer, as they plan and agree on the examination and search strategies (Bucholtz et al. 2015). The flow of information to the SIO gains importance when an arrest is made from the outset. The clock will begin ticking from the moment of detention, and unless credible intelligence, or evidence points otherwise, the suspect could be released from custody. Time frames vary, but a murder scene is likely to take a number of days to process. Traditionally, SIOs would want and expect as much information from the crime scene team as possible, and at the earliest. Scene managers are tasked with briefing all the investigators and specialists working on the case. The right attitude is to be open for discussion but be firm on areas of responsibility and terms of reference for each member of the team.

As with any complex process, crime scene management in major crime cases requires breaking down the work and processes into manageable parts and priorities (Sutton et al. 2016). Bodies, and biological remnants are always the first concern. Common approach paths are ways by which bodies can be preserved from contamination by clearly marking the edge of the cordon around the body (Heron et al. 2013). This is a complicated process, though. Crime scene

investigators determine the most likely path of entry, exit or movement of the perpetrator within the cordoned crime scene if it is determined that a route was taken by the offender, then special attention is exercised on the surfaces around that area so that the chances of recovering the remnants by him/her/them is maximized. Scene managers are therefore likely to work out alternative paths to move the body/bodies or allow medical examiners and their teams to enter and/or exit the scene without contaminating or preventing successful recovery of potentially valuable evidence.

Common approach paths are unlikely to work just by themselves (Horswell, 2004). Once a path is established, and inner cordon around the body is drawn up and securely maintained (Buckley & Langley, 2012). The determination of such is also the responsibility of crime scene managers, who use the body as a reference point in relation to the crime scene as a whole, in order to formulate and review the examination steps which would facilitate the efficient removal of the body from the scene, and effective investigation of the other areas within the larger scene in the meantime. Time constraints are part of the process, and despite possible indications at the scene, often convincing, the exact cause of death cannot be declared without a post-mortem examination. Preservation of the body and maintaining its integrity is thus an important factor in the outcome of investigations (Fish et al. 2013).

Before medical examination teams attend a scene, crime scene examiners, under supervision of scene manager(s), will keep extensive documentation on the state of the body and its surrounding environment, so as to create a timeline that can be used during the post-mortem (Goodall & Hawks, 2015). The temperature close to, and around the body will be taken at recorded intervals. The reason for this is that external conditions can affect the temperature of the body itself, which might have an impact on the determination of the time of death. Once the medical examiner or pathologist arrives at the scene, they attend to the body where it originally was found. The crime scene team work with the medical examiner in order to enable removal of the body, and recovery of any immediately obvious evidential material around the area (such as under the body). The taping of fibres or removal of items of clothing can take place at the scene itself, if they are likely to be contaminated when the body is placed in a body bag, or while being transported to the morgue.

Key information is relayed to the SIO on the impressions of the crime scene and the team's thoughts on the investigation to date (Millen, 2008). It is often the case that the debrief reveals the need for an additional round of work either at the crime scene, or on the collected evidence. Regardless of whether a suspect was in custody, the investigation is likely to continue both at the crime scene, and away from it. The crime scene manager is usually tasked with scheduling the arrival and departure of team members, and outside specialists, and for booking and briefing

any additional support that is needed to further the investigative goals set out by the senior investigating officer.

In the case that an investigation spills over to the next day, the following usually starts with a review and a continuation of the examination plan (Horswell, 2004). The SIO and the crime scene manager would ensure that the rationale behind the search and recovery strategy is sound, well-documented and communicated to all the search team members (Kars & Van den Eijkel, 2016).

Once the examination is concluded, the crime scene manager and the SIO would work out when to release the scene back to its owner, and discuss the appropriate crime scene clean-up options, which would often be undertaken by contractors in the case of heavily contaminated scenes (Houck et al. 2017). It is therefore unquestionable that crime scene managers are tasked with a multitude of duties and responsibilities to ensure the proper processing of a crime scene, with everything from operational decision-making, to administrative tasks, and coordination with the wider investigation teams under their purview. However, their responsibilities are still not done.

It would often be the case that an investigation does not turn up any worthwhile leads and is filed away as unsolved. In the UK, it is common practice that such cases are reviewed by a second senior investigator. This usually takes place at the 28-day mark and is intended to provide the case with a fresh set of eyes and a different perspective from the original investigator (NAO, 2008). Reviews take place to challenge and test the investigation, run through the assumptions and major lines of inquiry, investigative priorities and the forensic and crime scene investigations associated with the case. Despite the objective not being such, errors and oversights of the original team may be uncovered during the review. In these circumstances, the reviewing senior investigator may bring on board his/her own team of investigators, including a crime scene manager to assist.

The review process is extremely important and valuable when carried out in a professional and diplomatic manner (Villiers, 2009). The ultimate detection and outcome of the case is benefited greatly by the review, as it tests assumptions and assists in the culmination of ideas that can lead to successful closure of the inquiry.

Crime scene managers are also responsible for the resealing and extensive notetaking of items recorded into evidence. This is essentially a double-check on work done by the other crime scene staff. As far as quality control goes, they are also tasked with ensuring compliance with ISO/IEC and FSR-issued standards (Brandi & Wilson-Wilde, 2013). The 17025 standard, however, was specifically drafted for laboratories and is attributable to technical competence rather than competence of individuals to objectively secure, assess, and interpret data. There is

a practical benefit to using the 17020/25 standards, though. They are consistent worldwide for all forensic providers. It places responsibility for achieving and maintaining the standards on senior managers as well as individual forensic practitioners. The ISO standards afford competence at the corporate level by expecting training plans, records, and for personnel to observe demonstrations of various procedures during the accreditation inspections. Despite the expectation that the organizational policies, practices, and procedures will ensure competence every member of the team, it is not possible for the assessment unit to evaluate each individual at every visit. During an accreditation visit, they may inspect records of the practitioners to make sure that they have received training, professional development, and carried out any competence testing. But, this may not be for everyone across the board.

Therefore, inside the ISO 17020 and 17025 standards, there is organizational accreditation within policy and process and a decent overview of personnel competence, but ongoing individual accreditation is more down to the process rather than continuous testing of the individual. The key is not necessarily the policy and process, which are significant, but the demonstration of individual competence.

The entire system depends on a 'standard operating procedure' (SOP) or best practice framework to work (Wallace Jr et al. 2016). Herein lies the challenge. There are seldom any accepted SOPs when it comes to scene work, as it is argued that every scene is different and unique, well-planned approaches are required for each instance. SOPs are usually attributable to crime scene photography (Fish et al. 2013). Assessing staff crime scene competence and performance beyond image capture, therefore is a major dilemma for both policymakers on a national or state level, and individual organisation quality control managers, who are already tasked with an overwhelming workload and responsibilities. There are several possible strategies though, to address these shortcomings, each with its own set of challenges, also potential to move towards a more robust and efficient system of QA and QC.

Alternative Quality Control Strategies for Crime Scene Work

Having identified and discussed in detail the challenges that crime scene QA and QC systems, as well as the wider forensic sciences face in both implementation and practice, alternatives and strategies to address these challenges and work towards possible solutions becomes even more important. As discussed earlier, great emphasis is placed on 'competence' and 'competent' service, but the definition and meaning of competence is rarely examined in any great detail in crime scene contexts. This is a useful starting point for inquiry, but will be followed by model-based approaches, proficiency testing regimes, continuing professional development programmes, accreditation schemes, education and training programmes, ethics and the

scientific method, and perhaps most importantly, echoing the previous chapter, the importance of a robust knowledge and data-sharing infrastructure and policies.

Addressing the Meaning of Competence in Line with Organisational Goals

The definition and scope of competent practice (including what constitutes the scientific method) will often be determined by individual quality control managers and is largely dependent on the type of organisations to which practitioners belong. Lam (2000) highlighted a general overview of varying types of organisational typologies, which are relevant to this discussion. The general requirement for organisations to be classed as 'professional' was found to be dominant explicit knowledge and the standardisation of work practices, where labour market operates at an occupational level. There are also those organisations which are 'bureaucratic', operating at a collective level and within an internal labour market model. Within the former, individual professionals are key knowledge agents and the overall capabilities of the organisation are often derived mainly from the 'embrained' knowledge of highly trained, comparatively independent workers. The individuals within the 'professional' model will usually have high levels of formal education and training, leading to quite high standardisation of knowledge and skills within the organisation to which they belong. Standardisation can thus be described as originating from outside the organisation, with external education and professional bodies playing a significant part in articulating and solidifying the ingrained standards and quality of knowledge within the individual organisations. Individual and functional specialisation are known characteristics of such organisations. With regard to forensic science, these facets can be found to exist with the 'practice domain' of the discipline, with high importance given to the role of highly trained, expert professionals within both crime scene work, as well as laboratory practice. Other members operating with the criminal justice system, such as lawyers and prosecutors operate within structures that share the traits of this typology. But, with the human oversight model of QA in crime scene work, classing them as professionals with any conviction is problematic, especially due to their seemingly limited autonomy in major crime scenes. This issue could be addressed though, if more confidence in individual scene practitioners could be placed without such supervisory oversight, through a change in the organisational philiosophy.

Introduction of Structural Models and Model-based Policies

The organisations functioning within the 'bureaucratic' model are often highly effective at maintaining well-organised and stable approaches to projects. These organisations are known for the formalisation of operating skills with codified procedures that reduce uncertainty in tasks. They are well-prepared to address known problems within the occupational domain, as the organisation will typically have a knowledgebase that has been derived from the

formalisation of cumulated information. The focus is seldom of the individual, with the emphasis being given to the management hierarchy. The legal/policy domains are examples of this model being utilised. The characteristics most on show are those of stability, formalised knowledge, and the codification of knowledge. Ensuring transparency, and fairness across the criminal justice system is paramount, and the bureaucratic model works well to maintain parity across the individual and collective cases that pass through it. Another area where the model can be seen to be dominant, is where law and policy intersects with investigative endeavours. Examples of these can be the execution of search warrants, and the collection of evidence with due concern and respect for the criminal procedure rules.

The models and structural specifics can only be utilised and put into practice by the organisations employing the services of crime scene workers, or those that have a direct or indirect interest in the outcomes of that work. Integration of quality assurance philosophies and the success of the same therefore, can largely depend on the powers of these organisations or bodies to regulate conduct and enforce standards. This has however, due to a lack of unified implementation of nationwide QA/QC strategies, been proven to be a major challenge, especially in the UK.

Implementing Certification Schemes Through Proficiency Testing

A cultural shift within police organisations towards personal accountability and the professionalisation of scene staff would require robust individual competency testing regimes to periodically ascertain and maintain high standards and improvement in service. One such system is proficiency testing (PT), which can be described as a blind test submitted to an analyst for processing. Samples submitted in this manner will require analysis following the laboratory's standard procedures and a final report submitted to the test provider, who will then decide whether the expected outcome had been achieved. Any shortcomings will then be required to be investigated and addressed. Proficiency testing can be both internal (prepared by someone else within the laboratory) or external (procured from an external provider or supplied by another laboratory as a collaborative exercise). It serves as a quality control exercise for both the individual(s) (i.e. competency of the analyst) and the laboratory (i.e. validity of test methods, equipment, reagents, etc.).

Crime scene investigation, because of its subjective nature has traditionally presented a definite challenge in developing a concept of how to test crime scene investigators (Horswell, 2004). Commentators have suggested that such testing could involve both written and oral tests and cover wide variety of crime scene activities (Shaler, 2011). Any internal/external proficiency test for crime scene work will need to cover performance assessment in a combination of the following areas: initial assessment of the crime scene; control of the crime scene; examination

of the crime scene; interpretation of evidence at the crime scene; recording the crime scene and evidence; evidence collection; and case management. Australia was the first to have a formalised quality assurance and proficiency testing system for crime scene investigators, and field forensic scientists. This is now an established system within Australia's National Association of Testing Authorities (NATA), and Forensic Science Laboratory Accreditation Programme (FSLAP). The UK does not have such a programme in place, but crime scene examiners in the jurisdiction can take advantage of programmes in other countries, if their host organisations authorise it.

One such organisation is the International Association for Identification (IAI) which offers a varied number of recognition programs that require applicants to successfully complete a series of proficiency tests that includes ten-print and latent-print, bloodstain pattern, footwear, forensic art analysis, forensic photography, forensic video, and four levels of crime scene investigation (http://theiai.org/certifications). Successful certification underscores competence to perform crime scene duties when qualifications are under scrutiny in court.

Certifications are often designed in a format that is two or three steps, in order to encourage continuous professional development and build expertise on specific areas of practice. Written proficiency examinations, as stated above, are essential to ensure the credibility of the certification programs. There will most often be a requirement for applicants to complete additional years of service within a specific tier/level in order to apply for consideration and testing for the next step in the certification ladder. Accomplishments such as getting recognition among peers in the discipline demonstrate technical competency and enhance the veracity of the examiner's work, and courtroom testimony.

The largest professional organization of practitioners, researchers, and scientists is the American Academy of Forensic Sciences (AAFS), which has about 6,200 members in the United States and 67 foreign countries. The application of science to the law spans the spectrum of forensic disciplines and includes 11 sections, which include Criminalistics, Questioned Documents, and Toxicology. The AAFS publishes the Journal of Forensic Science and conducts annual meetings at which members from every profession—including engineers, dentists, educators, psychiatrists, lawyers, physicians, and many other fields of expertise—present research findings that enhance the practice of forensics from the crime scene to court.

A non-exhaustive list of organisations and bodies offering certification and accreditation services, can be found in *Table 6a*:

Organizations Offering Certifications and Accreditation in Areas of Professional Expertise and Training	
American Academy of Forensic Sciences (https://www.aafs.org)	High Technology Crime Investigation Association (https://htcia.org)
American Board of Criminalistics (http://www.criminalistics.com)	International Association of Arson Investigators (https://www.firearson.com)
American Board of Forensic Anthropology (http://theabfa.org)	International Association of Bloodstain Pattern Analysts (http://www.iabpa.org)
American Board of Forensic Document Examiners (https://www.abfde.org)	International Association of Computer Investigative Specialists (https://www.iacis.com)
American Board of Forensic Odontology (https://abfo.org)	International Association of Forensic Nurses (http://www.forensicnurses.org)
American Board of Medicolegal Death Investigators (http://www.abmdi.org)	International Association of Identification (https://www.theiai.org)
American College of Forensic Examiners	International Crime Scene Investigators Association (http://www.icsia.org)
Association for Crime Scene Reconstruction (https://www.acsr.org)	International Forensic Imaging Enhancement Society
Association of Firearm and Tool Mark Examiners (https://afte.org)	International Institute of Forensic Engineering Services (http://www.iifes.org)
Board of Forensic Document Examiners (http://www.bfde.org)	National Association of Document Examiners (http://documentexaminers.org)
Evidence Photographers International Council	

Commentators however argue that although certification and proficiency testing help build objectivity in the investigator, no level of certification or proficiency testing will eliminate the possibility of subjective interpretations, and that investigators should be wary of individuals, no matter what their credentials, who arrive on scene and arbitrarily put their final conclusion

before their analysis (Gardner, 2011). A high level of training and continuing professional development is thus required for quality assurance in crime scene work.

Establishing Continuing Professional Development Requirements

Routine monitoring and rectifications to working practices and procedures as and when fallibilities are identified, will help in ensuring high standards and an environment for continuous improvement. For example, if a particular dusting technique is seen to yield poor results, or degrade fingerprint samples, then the quality control/scene manager should alert not only the individual, but also every other member of the team about the flaw in the technique, and if needed, train them in a better procedure. The organisation that scene examiners belong to, will need to not only effectively respond to identified problems, but also be alert to technical and procedural developments in their field (e.g., through monitoring technical journals and publications, attending relevant conferences and symposia, etc.). Staff should be encouraged to be proactive with respect to introducing improvements into their working practices and operations. One method of ensuring continuing development is renewing or rolling accreditation schemes whereby staff have to undertake refresher courses or partake in professional development programmes to retain certification, and/or accreditation.

Enacting Practitioner-specific Accreditation Schemes

The FSR, in its Codes of Practice outlined the statement of accreditation requirements in the preface of the published document, but all of the requirements were for laboratory activity, and none for crime scene work (FSR, 2011). The Codes also made no reference to registration or accreditation for individual members of the forensic science community. This had been initiated in 2000, in the UK, under the auspices of a new non-statutory body known as the Council for the Registration of Forensic Practitioners (CRFP). It relied on a system of peer review which, while not perfect, was arguably better than judgements made by users of forensic science services who might be impressed by results regardless of how they had been achieved (Wilson & Gallop, 2013). But in 2009, Home Office funding was withdrawn, and a register of more than 3,000 independent experts in fields such as fingerprinting, ballistics, computing and DNA lost relevance (Guardian, 2009). Instead, the CRFP was replaced by the Forensic Science Regulator, pledging to introduce a new regulatory system for forensic experts. The regulations have been in the process of being formulated for an extended period (Home Office, 2013).

The CRFP was established to give the courts a single point of reference on the competence of forensic practitioners, with the overriding aim to promote public confidence in forensic practice in the UK (House of Commons, 2005). It was set to achieve this through publication of a register of competent forensic practitioners; ensuring that registered practitioners stayed up to

date and maintained competence; and disciplining registered practitioners who did not meet the required standards (Home Affairs Committee, 1999).

Accreditation offers several advantages which made the CRFP a worthwhile venture, including transparency, traceability, and accountability. It benefits both the provider of the forensic science service, and its clients. For laboratories, a clearer understanding of the work that is undertaken and the manner in which it is done will benefit management to address shortcomings and improve services. This information is documented so that it is easier to communicate to new employees undergoing training and development. The client/end-user can have a better understanding of how the product or service has been rendered, meaning in the case of forensic services, it can add value and reliability.

It may also be easier for the end-user/client to choose which provider has the best service to meet their specific needs. Accreditation can, by its nature add a certain level of harmonization between laboratories, as the conditions to fulfil are the same and ISO/IEC 17025 gives a common backbone to all laboratories seeking accreditation. By making comparisons between laboratories possible, their quality standards can be evaluated more easily. This facilitates an opportunity for end-users/clients to compare facilities beyond their national borders and take advantage of the international market. Furthermore, international collaboration based on criminalistics may be simplified by the common approach (Malkoc & Neuteboom, 2006).

In crime scene contexts, accreditation can be a system of ensuring competence, as well as identify scene staff best suited for individual crime scenes. Expertise, experience and skills can be endorsed, and it can be a one-stop reference system for criminal justice actors to see who processed the evidence in the cases they are prosecuting, defending or hearing.

There are however, disadvantages to accreditation, the principal being the initial cost of implementing the necessary measures and permanent cost of attaining and maintaining accreditation. Often at times laboratories may feel that the extra paperwork and administrative effort put into getting accreditation is disproportionate to the gain resulting in implementing all the measures. Loss of flexibility in applying non-validated techniques or implementing new methods can also be seen as a negative. Each change must be documented according to procedures and accepted for court purposes, which requires allocation of time, personnel, and expenses. It can also be argued that quality of work may become limited, as a tendency may develop to comply only with the standards imposed by regulations (to get certified/accredited), instead of using what could previously have been higher internal standards. Accreditation has the potential to be used to limit competition with other laboratories by fixing high standards so that not all (private) laboratories can follow them. However, many of these criticisms are

addressable when it is understood that accreditation only sets the minimum standard to be attained, and not the top standard.

The FSR itself does not engage in any direct involvement in certification, accreditation, or standardisation of laboratories, or individuals (CRFP, 2008), instead, placing its confidence in forensic science managers to ensure competence (FSR, 2013). There are however suggestions that they tend to devalue managerial aspects of their jobs and may not be sufficiently trained in science or management to fit their job descriptions (Houck et al. 2009).

For laboratories to claim to be 'accredited by the Ministry of Justice' in DNA analysis (Orchid Cellmark), it only requires approval by an accreditation body (private) which complies with the requirements of ISO/IEC 17011, formerly ISO Guide 58 (HM Courts & Tribunal Service, 2014). And, in the absence of state accreditation for academic institutions delivering forensic science undergraduate and postgraduate courses, registered charity, the Chartered Society of Forensic Sciences (CSoFS, formerly the Forensic Science Society), has an accreditation scheme, giving quality endorsement of courses offered (CSoFS Website; Jackson & Jackson, 2011).

Beyond the traditional paradigms of quality assurance in forensic science, however, is the understated matter of formal education and training, which can familiarise and prepare crime scene personnel for the field. Despite the lack of mention of this facet of quality assurance in law enforcement role profiles (see Chapter Five) or academic literature in general, its significance cannot be devalued, leading to a need for further examination of the role of education in crime scene competence.

Ensuring Quality Assurance Through Education and Training

The approaches to forensic science education, particularly crime scene sciences, point to an understanding that robust training and development programmes with a minimum quality standard will ensure graduating students, and new crime scene staff, to be quality candidates who can process scenes to the standard that would satisfy hiring organisations, and ultimately scrutiny in court. It could be described as a ground-up approach to quality assurance — a form of grassroots mechanism to safeguard against unqualified candidates entering the crime scene discipline.

Increased interest in forensic science over the last two decades have led to an increase in the number of forensic science courses offered by UK universities, mainly at undergraduate level with some expansion at postgraduate level (Mennell, 2006). An accreditation system for forensic undergraduate and postgraduate courses was introduced by what is now the Chartered Society of Forensic Sciences, allowing undergraduate and postgraduate university courses (both

in the UK and outside) to attain CSoFS accreditation in three broad areas. These are Forensic and Crime Scene Sciences, Digital Forensics and Forensic Anthropology and Forensic Archaeology. The system is based on a series of component standards. For instance, in order for a course to be accredited, it must comply specifically with the Interpretation, Evaluation and Presentation of Evidence (IEPE) Component Standard.

The CSoFS (2017a) describes the IEPE standard as a method for guaranteeing that students gain adequate abilities and information to record evidence and all parts of experimentation, managing data, interpreting evidence, and efficiently presenting written and verbal communications, and fulfil their desired outcomes in a large number of legal and non-legal settings.

Courses are intended to empower students with the knowledge and skills to record observations and experimentation, including experimental design, in a sensible, exhaustive and contemporaneous manner with proper regard to established codes of good practice; comprehension of the prerequisites of evidence continuity; exhibit the right utilization of contemporaneous notes, including facts and information to be recorded; understand the function and procedures of quality assurance; assess diagnostic information from instrumentation connected to scientific assessments including the utilization of suitable tests; interpret results in a meaningful and organized way with regards to casework; express the interpretation of results in a way understandable to the intended information recipients, for example, lawyers or a jury; demonstrate how to evaluate the recurrence of evidential materials to assist in interpretation of analytical results; show a comprehension of how to set up casework-related experiments; exhibit awareness to the accessibility and utilization of databases to aid interpretation; write comprehensive, comprehensible, rational and unbiased reports; demonstrate good oral and presentational skills that would empower the student to be comprehendible in the courtroom; exhibit how the scope of an investigation influences the forensic strategy and proportionality of the actions to be taken; demonstrate a comprehension of safe working practices (individual security, wellbeing of colleagues and others present etc.); demonstrate an understanding of the issues pertaining to conflict of interest and legal privilege; and exhibit effective work as part of an investigative team (CSoFS (2017a).

There are also guidelines that are described as specialist outcomes. The digital forensics specialisation expects students to demonstrate awareness and understanding of prevailing standards applicable to digital evidence (e.g. ACPO Good Practice Guide for Computer-Based Electronic Evidence, Forensic Science Regulator's Standards, and ISO standards) and be able to demonstrate their application in context.

In addition to the IEPE standard, courses, under the CSoFS (2017a) guidelines, must also meet the requirements of at least one, but usually both, of one of the following three pairs of Component Standards:

For courses based in Forensic and Crime Scene Sciences: (1) the Crime Scene Investigation Component Standard; and the (2) the Laboratory Analysis Component Standard, are noteworthy.

For the purposes of this chapter, the CSI standard is most pertinent, however. The standard's purpose is expressed as furnishing students with a comprehension of, and capacity to, play out the strategies engaged with crime scene investigation whilst working within a quality management framework. The guidelines depict 'appropriate crime scene management' and 'scene investigation' as crucial to guaranteeing the efficacy of resulting lab-based scientific assessments of the evidence gathered. Crime scene work is expressed to be 'at the core of forensic science practice'. The standard further states that it is impossible in many contexts for laboratory analysis or post-analysis interpretation to overcome shortcomings introduced at the crime scene examination stage, which makes it indispensable for students to be equipped with both a hypothetical and functional understanding of sound crime scene processing techniques and be given adequate time to practice those aspects that require skills development.

The CSoFS (2017b) standard additionally requires institutions offering courses to enable students to learn and describe the roles, obligations and liabilities of all staff engaged in the processing of crime scenes, with specific accentuation on police scientific support, for example, Crime Scene Investigators (CSIs), Crime Scene Managers and Crime Scene Coordinators or their equivalents, in addition to Senior Investigating Officers (SIOs) and other police personnel.

Students are expected to understand the regulatory framework of their own jurisdiction and, where applicable, the role of ISO accreditation. In the UK (particularly in England and Wales), students are envisaged to be aware of the Forensic Science Regulator’s Codes of Practice and Conduct, and the ACPO Good Practice Guide for Digital Evidence in as far as it pertains to crime scene processing; as well as the roles of specialists who may attend crime scenes, such as accident and emergency service personnel, anthropologists, archaeologists, pathologists, forensic medical examiners, scientists, fingerprint experts, bomb disposal experts, engineers, entomologists, fire service personnel, fire investigators, odonatologists, CCTV data recovery / technical experts, photographers and surveyors.

The standard also places emphasis on students with understanding that there is specialist emergency personnel, involved in what is referred to as ‘scene stabilisation’. These include police (First Attending Officers), Ambulance, Fire & Rescue (Army-Explosives Ordinance Disposal (EOD), Coastguard, RNLI, Structural engineers etc.). Such individuals are called

primarily to make the location safe (arrest suspects, offer first aid, ensure location is safe etc.) and any forensic issues are secondary.

There is also an expectation that all those involved in stabilisation should have specific forensic awareness training so that they can minimise avoidable loss, contamination or degradation of potential evidence. Any activity undertaken by these individuals or groups to preserve potential evidence must not compromise their personal safety or safety at the location. Integral to this is the understanding of the potential complexity of crime scene investigation (including those of incidents of volume crime (including vehicle crime) but specifically with reference to serious or major crime) and varied practical and legal constraints that are incidental to the job, including the need for timeliness, within which the investigator must work.

Courses are also expected to demonstrate an understanding of the information needs of all personnel involved in crime scene work and the processing of physical evidence, with emphasis on the ability to convey information of this type in an appropriate form. Particular importance is placed on the information that must be provided to and by CSEs, or their counterparts, where oral and written communication skills are paramount for effective crime scene processing.

The guidelines call for students to understand and explain both the evidential, and intelligence value of information obtained by crime scene investigation, referring to the philosophical difference between the use of information for evidential, and intelligence purposes. It is stated that when used as evidence, the purpose is to compare the probability of obtaining that information if one proposition (i.e. that of the prosecution) is correct with the probability of it being obtained if another proposition (that of the defence) is true. When used as intelligence, the purpose is to use that information to establish the most likely explanation(s) for the presence of that information.

Quality assurance is given consideration in the guidelines. The understanding of how and why mistakes in crime scene processing can jeopardise the value of any subsequent forensic examination in the laboratory and the evidential value of materials and data obtained from the crime scene is highlighted. It calls for information obtained by crime scene investigation to be used to support the needs of the investigation and to evaluate both potential forensic evidence in the context of a given investigative circumstance and case-specific evidential requirements. An expectation is placed on students to demonstrate a full understanding of the critical importance of crime scene investigation in the crime-scene-to-court chain and critically evaluate crime-scene-processing case studies.

Students are called upon to familiarise themselves with the strategies and procedures that should be used to minimise the chances of such mistakes, being made aware of the types of analysis that can be used in the laboratory and the implications that these have for the strategies

and methods used during crime scene processing. Case studies are cited as potential sources for use to show how errors can occur and how they can be avoided. Students are anticipated to be tasked with evaluating both real and fictitious case studies and develop good crime scene processing practice, while maintaining independence within the investigative process. Understanding the nature and potential impact of cognitive bias, and how the impacts of such bias can be minimised is cited. The guidelines also make reference to the importance of understanding the tension between the potential that contextual information has for enhancing the probative value of evidence and its potential to bring about cognitive bias.

The standard procedures referenced by the CSoFS (2017b) point to safe working procedures, where students are tasked with developing skills of dynamic risk assessment and those required for the creation of risk assessed standard procedures. Where investigative requirements and the appropriate responses are tested in simulated crime scenes.

Despite being reinforced in theory, crime scene processing is described by the guidelines as a practical subject. Students are pointed to experience the processing of a variety of realistic mock crime scenes (including vehicles) in order to gain the necessary practical skills. These can be indoor, outdoor, day or night.

Aside from the CSoFS (2017b) codes and guidelines, Sector Skills Councils are organisations which aim to create skills systems that meet the needs of employers across the UK. As referenced above, Skills for Justice is the Sector Skills Council for the Justice, Community Safety and Legal Services sectors. It operates Skillsmark, described as a Quality Framework for Learning and Development in the Justice and Community Safety sector. Higher education providers have the option of applying for Skillsmark endorsement of their learning programmes. In order to successfully gain endorsement, providers are required to demonstrate that they are effective in the following areas: (a) assessment of the needs of employers and the appropriate use of external benchmarks when constructing the learning programme; (b) the design and development of the learning programme so that its learning outcomes and aims can be achieved; (c) the delivery of the learning programme and the support that is given to those studying on the programme; (d) keeping the learning programme up to date and responsive to the needs of employers and learners.

The UK's Quality Assurance Agency for Higher Education (QAA) also published a subject benchmark statement for forensic science in 2012. It described the nature and extent of forensic science, for both bachelor's degrees with honours and master's degrees in the discipline. The benchmark statement defines what the course should aim to enable those studying it to achieve and, what the course should cover in terms of knowledge, understanding, skills development and ethical matters. It also prescribes expectations for the teaching, learning and assessment

methods utilised. Importantly, the benchmark outlines standards of achievement that graduates are expected to have attained in general subject-related abilities, skills and knowledge; crime scene investigation; laboratory analysis; and, interpretation, evaluation and presentation of evidence.

Therefore, while the role profiles attained in this theses may have given the impression of minimal educational standards in entry into the crime scene discipline, in conjunction with UKAS, and the organisations discussed above, the standards and quality assurance ecosystem within forensic science cannot be understated, but may leave a lot to be desired. More specifically, regardless of the education or training attained, the ultimate responsibility to maintain quality standards will be vested in the individual practitioners attending the scenes, as managers or supervisors may not always be able to attend every scene. It also raises a question of whether investment into individual Force quality assurance/control systems rather than a general Higher Education Institution (HEI) quality framework would be beneficial to law enforcement bodies, based on the findings of the previous chapter.

Instilling Ethics, Personal Responsibility and the Scientific Method

Personal responsibility and human monitoring can be argued to be at the forefront of the existing model, with the underlying theme of the quality assurance standards for education and training in the forensic sciences, and particularly in crime scene investigation being individual accountability. Emphasis is seen to be made as a coefficient that scene examiners, from the student and scholar stage to professional level are expected to be prepared for practical scenarios where, barring safety measures, standard operating procedures most often do not apply. As also seen above, there is little to no accreditation or certification schemes specifically designed for or aimed at crime scene examiners. Quality assurance should thus be a matter of instilling the philosophies originating from the scientific method, whereby individual crime scene practitioners undertake their responsibilities in a manner which minimises errors, misconduct and/or biases.

The Randox Testing Services (RTS) scandal was a major wake-up call for UK forensic science stakeholders in 2017, after it was found that about 10,500 test results were at risk of manipulation. The National Police Chiefs' Council (NPCC) called it the "most serious breach" of forensic science standards in the jurisdiction (BBC, 2018). Forty motorists had their convictions quashed, while fifty court cases were also dropped as of the first week of December 2018. Two arrests were made, and Police Minister Nick Hurd confirmed that RTS was no longer working for the NPCC as a service provider (BBC, 2017).

The seriousness of the matter was heightened with revelations that among the 10,500 or so cases, there were around 1000 rape cases, and 300 homicides (Thompson, 2018). Ch Con James

Vaughan, NPCC lead on forensics, told the BBC that he could not remember a forensic science failure of such a magnitude (BBC, 2018). The FSR responded by detailing guidance to all major forensic toxicology suppliers that they would be required to carry out a detailed audit of a sample of their cases (ITV, 2017). However, the Guardian (2017) reported that 10% of the samples were no longer held and could therefore not be retested or relied on.

Randox maintained on their website that they had full ISO 17025:2017 accreditation to perform a wide range of drug and alcohol testing (RTS, 2018). They also stated that each customer is assigned a dedicated Account Manager who manages "the entire process of implementing workplace testing" — further accentuating the importance placed on dedicated managers in forensic testing facilities. Additionally, one of their biggest claims was of a global network of trained collections specialists who guarantee, through strict chain of custody procedures, the integrity of the collected samples.

It is not the first time a scandal of this kind had hit UK law enforcement. The Metropolitan Police had suspended a scientist in March 2018, after being concerned with the quality of her work in 33 cases, 21 of which were rapes and sexual assaults, with the others involving serious violence, drug offences and burglary (Guardian, 2018). The member of staff from Scotland Yard's forensic services was alleged to have failed in carrying out tests and to have wrongly informed investigators about how her work was progressing.

It is worth noting that Metropolitan Police Service was the first police force in England and Wales to gain UKAS accreditation in 2010. Under ISO/IEC 17025:2005 the force was accredited for forensic activities undertaken in its Evidence Recovery Unit laboratory after the then-FSR had recommended that all providers of forensic science services gain UKAS accreditation in order to deliver confidence in their results (UKAS, 2010).

In 2012, Adam Scott, from Devon, was held for months after being accused of raping a woman in Manchester (BBC, 2012). Prosecutors dropped the charges after it was found that private provider LGC Forensics contaminated DNA samples in their laboratory resulting in the false arrest. Scott was charged on 23 October 2011 after a plastic tray containing a sample of his DNA was re-used in the analysis of a swab from a rape victim in Plant Hill Park, Blackley. The result of that test linked him to the crime, even though no other evidence had connected him to the case.

The then-FSR stated in his report that the contamination was the result of human error by a technician who failed to follow basic procedures for the disposal of plastic trays used as part of a validated DNA extraction process (FSR, 2012). The procedures were also not adequate, meaning that records were not being maintained by the technicians and nothing was being done

to mark trays once they had been used. As part of the inquiry, a further 26,000 samples were checked.

LGC Forensics, a member of ENFSI, claimed ISO 17025:2005 and ISO 9001 accreditation through UKAS in 2015, and became a part of Eurofins Scientific, a European provider undertaking testing in France, Germany and Belgium. During its operation as an independent provider, it had listed 120 accredited methods for forensic sample analysis — claiming to be more than any other provider (LGC, 2017). Whether this would prevent future errors, such as those in the Adam Scott case, cannot be stated with any certainty.

In the U.S. Annie Dookhan, a chemist, having no college degree, forged her way into a Massachusetts drug testing lab, working on 40,000 cases before being caught contaminating evidence in 2014 (Driscoll, 2014). She admitted to 'drylabbing'— a practice whereby, instead of actually conducting tests, she would just eyeball samples to guess what they might be. Dookhan's lab results influenced thousands of pleas from defendants, with nine cases at U.S. Superior Court level. Seven Massachusetts counties dropped more than 21,000 low-level drug cases tainted by the work of a rogue lab chemist (NBC News, 2017).

The argument can thus be made that regardless of the level of accreditation, validation and standardisation of processes in the forensic sciences, unqualified or incompetent work can still be the norm if individual members of staff are not properly trained, tested and then periodically retested to ensure competence. It could also further the case that a mindset change could be needed on the part of law enforcement and other hiring bodies. The Randox, LGC and Met Police scandals showed that quality assurance through institutional accreditation does little to prevent errors and malpractice. A ground-up approach, rather than the top-down strategy that is presently the standard would arguably ensure personal responsibility, and an adherence to quality standards not just because of the threat of punishment (if caught) but because it is ethical. It can be argued that a return to the approach of scientific endeavour rather than mainly concentrating on the mechanistic validation of processes is critical. In addition, incorporating an awareness of the requirements of the law in its broadest sense (Edmond et al. 2016; Raymond & Julian, 2015) and introducing research into both practice and policy within forensic science (Koehler & Meixner, 2016; Mnookin et al. 2011) is required.

An adherence to the scientific enterprise will require incorporation of both empirical and expert evidence bases. The FoRTE model has been suggested as a means of articulating a conceptual understanding of the components of forensic reconstructions utilising trace materials (Morgan, 2017). The model presents a route to a problem-solving approach that brings together empirical evidence bases and the expertise of practitioners within the forensic science discipline. The introduction of such a holistic and systematic view of forensic reconstruction may have the

promise of offering a translucent and evidence-based standing for adopting an 'ongoing critical perspective' (Mnookin et al. 2010: 726).

Such an understanding has the potential to lead to effective questions being asked, appropriate analyses being undertaken, and the expression of robust inferences, contributing to a distinctive 'forensic science culture' (Gertner, 2010). This perspective can ensure that research is focused on the critical questions needing to be answered that underpin forensic science and ensure the potential of evidence is unlocked and can contribute to effective forensic reconstruction approaches. To identify potential routes forward within the forensic sciences, an understanding of the strengths, weaknesses, and the unique requirements of the intersecting realms of research, practice and policy/law is needed. Formulating the dominant forms of knowledge and approaches to innovation within different institutions, is vital to appropriately making use of any conceptual model within the development of forensic science.

The scientific method, if applied correctly, can be argued to be one of the most effective means of eliminating bias in crime scene work, where few checks and balances exist in the way of abstract systems. By its very nature, the scientific method applies checks and balances through the hypothesis, experimentation, and feedback processes that give reliability to other scientific endeavours. For students of science, this process is a familiar one. For scene investigators, this may be a foreign concept regardless of their rank or level of experience. For scene investigators as opposed to scene scientists (a distinction that is largely unclear even amongst commentators), the approach is not necessarily cut-and-dry as it offers only a sketchy roadmap of how to conduct a competent scene investigation. This is an understandable by-product of the scientific method.

Scientific processes are by nature, complex. Scene investigations share the same facets of complexity and are scientific endeavours in their own right (see Chapter Three). Using any operational guide for conducting scene investigations is difficult, as every scene is different, and each investigation requires a tailored approach. Scene scientists are tasked with judging facts, which requires the separation of said facts from hypothesis and suppositions. Facts can be hard (such as scientific data and observable phenomena) while others are soft (such as witness statements). Skilled scene investigators stick to hard facts, while adopting supportable soft facts into the overall picture. Each new fact must pass tests against appropriate hypothesis. It is only when all/most of the facts are known can a scenario of what happened be reliably articulated. If facts do not fit an established hypothesis, these too must have an explanation — leading to new, modified, or alternate hypothesis. In the absence of this process, investigations can thus be prone to errors in judgment, or bias, leading to poor quality work (Dror & Rosenthal, 2008).

However, regardless of a top-down or bottom-up approach to ensuring quality, unless policies are uniform, and enforced across the board, the effectiveness of the strategies would leave much to be desired. Policy uniformity and enforcement have been cited as major hurdles to forensic science realising its full potential (Arvizu, 2000) and must thus be the first priority of policymakers and stakeholders.

Establishing Robust Knowledge and Data-Sharing Infrastructure and Policies

If any quality assurance and control mechanisms are to be implemented and effectively enforced, distribution and knowledge-sharing systems would need to be enacted across jurisdictions and maintained vigorously. There is great concern among policymakers about the future of the forensics market in the UK (House of Commons, 2013), and the U.S. (NAS, 2009a). In England and Wales, there is a significant lack of data on the overall size of the forensics market and the proportion of it delivered in-house by police force laboratories, a lack of consistent accounting practices across police forces making it challenging to get a complete picture of forensics expenditure, and absence of an official strategy to ensure the forensic market is in good health, both in the short and long-term (NAO, 2014). At the heart of the debate in both jurisdictions for over a decade has been issues related to the quality of forensic practice, specifically objectivity, accreditation, certification, reliability, error analysis and the need for, and nature of, sustained focused research (Ubelaker, 2012). The UK Home Office only recently produced a strategy for forensics (House of Commons, 2016) , but no central framework to govern the discipline or its practitioners exists (Home Office, 2013), and the same applies to their American counterparts (NAS, 2009b).

The Home Office does not possess policy latency data (Home Office, 2013) and if policy is to change in the UK, the effectiveness of the Forensic Science Regulator, and the guidance published from the office of the same, must be placed under the microscope. While NAS (2009a) successfully highlighted the problems that blight U.S. forensic science providers and practitioners, the latency between policy and practice remains largely conceptual, without field data.

The Home Office and Forensic Science Regulator only have partial access to performance data, service quality and management information, quality management and accreditation, and the physical security of evidence in the forensic service providers' custody (NAO, 2014: 6). Neither body has the ability to compel any provider to provide quality assurance data, and even forces are not obliged to provide this information (p. 7). The data that does get collected relates to police force expenditure, market information through the Forensic Management Information Tool (FMIT), supplier monitoring data such as turnaround times, accreditation status (of

laboratories), and organisational financial health (p. 5) — none of which have nexus to individual competence of forensic science professionals.

A robust knowledge-sharing regime would not only allow for policymakers to make more informed decisions, but also to monitor organisations in breach of guidelines. Accreditation, training and professional development information would be useful indicators to press organisations lagging behind and keep them on the same standard as other forces. A more uniform quality assurance strategy would assist in an overall better service across the jurisdiction than varying levels of quality in different forces. Common regimes of data collection, logging, storage and networking would therefore have to be at the forefront of policy change in the area. It would also facilitate movement of scene staff between forces and allow for better collaboration schemes and cooperation regimes.

CONCLUSION

Generally, quality service is understood to be only as good as the quality of those providing it. Personnel working in forensic science will thus need to be aptly qualified and experienced for the activities they are required to perform. Appropriate training and competency testing are also a necessity before staff are authorized to undertake casework (or related analytical activities) unsupervised. Regular monitoring of performance, via periodic proficiency testing or the evaluation of QC data produced by them is key. Records are required to be kept regarding staff training, competency testing, casework authorization, and performance monitoring. Robust knowledge-management and sharing systems would be essential to ensuring quality. High-profile scandals have shown that institutional redundancies are not enough to prevent incompetence, fraud or inefficiency in forensic science. It was therefore suggested that a move towards a ground-up strategy of skill-building, knowledge-sharing and professional ethics development be implemented by policymakers. Any strategy or policy would require a standards body to have enforcement powers to ensure compliance. Barring establishment of support organisations on a state-level, the cooperation between private actors who are already fulfilling roles within the quality assurance infrastructure can be integrated more cohesively under a unified approach that is scalable to account for large and small police forces, and varying budgets.

CHAPTER SEVEN

The previous chapter examined the role quality assurance, control and standards can play on the entry, operation and even exit of practitioners in forensic science, and crime scene practice. Scene staff numbers have been steadily declining over the years (see Chapter Five), and technology is encroaching police work. Austerity regimes have historically tended to favour mechanisation and automation to decrease costs and increase efficiency. And, in times of austerity, decreasing investment and falling numbers in crime scene practice instigate questions about the potential future of the discipline. Additionally, the work that these practitioners undertake, as groups or individuals also carry work-specific risks. From biological hazards to personal safety, there are numerous risks associated with crime scene work. However, the larger, looming risk of automation, deskilling and threat of replacement by machines has been said to affect almost all occupations and professions across the board. Examining these threats from a sociological perspective, therefore has the potential to uncover valuable insights into crime scene practice, as well as the resilience of its practitioners to the speculated threat of automation in a technologically changing world.

A Traditional Aversion to Change

Hallcox & Welch (2009) found on their travels with law enforcement in the U.S., a phenomenon they described as F.O.G, or in unsavoury terms, [expletive] old guy — a reference to old-guard police staff averse to new developments. It touches upon a prevailing problem in forensic science and technological progression within law enforcement organisations, which have been historically slow to adopt scientific and technical innovations (Wall, 2017; Grieve et al. 2007; Kappeler, 2006).

Personnel within law enforcement were understood to be lagging some twenty to twenty-five years behind the rest of the United States, when it came to management strategies and technology adoption — instead, preferring to invest in blue flashing lights, sirens, weapons and combat gear (Hallcox & Welch, 2009). Forensic science was one of the areas which received the least consideration when allocating resources. Bureaucrats often did not have front-line forensic science experience, and this lack of exposure to the field handicapped their decision-making. The study found that law enforcement organisations were often reluctant to invest on fingerprint brushes or swabs, while still using outdated polaroid film cameras for crime scene photography, despite costing departments in excess of $100,000 per year. The switch to DSLR cameras would have cut costs, but decision-making in police organisations is seldom driven by logic but based instead on fear of personnel becoming obsolete.

The fear of being replaced by high-functioning and increasingly inexpensive machines can be somewhat justified. The attitude is reflected in a quality assurance philosophy that focuses on

supervision, or superintendence. However, safeguarding crime scene jobs through a system of quality control built around human observation and oversight, rather than systematic checks and balances through established quality assurance mechanisms as in other areas of forensic practice raises questions about the reliability of the work, warranting the comprehensive examination into the state of quality assurance in scene work in the previous chapter. These issues can also be examined with reference to, and using 'risk' as a framing device for sociological analysis.

The Risk Society & Technological Change

The concept of the risk society could be useful in framing this examination. It analyses of contemporary societies argue that risk has been a central, generalized preoccupation, which has been attributed to constructing contemporary institutions and contemporary consciousness (Beck, 1992a; Beck et al. 1994). A concern of the risk society has been the apprehensive attitude towards law enforcement organisations deferring their responsibilities of fairness and due process in favour of hard-line policies to crackdown on target groups and furthering executive agenda (Braithwaite, 1999). Law and order and ideals of justice have acted as a driving force for modern democracies both as a goal-setting attribute, as well as a legitimising component (Hudson, 2003).

Behind these mechanisms lie an undercurrent of anxiety. The fear of crime has been recognised as a problem in itself, separate from the actual crimes and victimization. These have led to distinctive policies with the objective of diminishing and controlling fear, rather than reduce crime levels. The use of scientific techniques in crime detection and prosecution also opened up new avenues of risk.

As the industrialisation in modern times created new technologies and risks arising from them, the need to accurately assess, manage and contain human-created risks became more important (Ansell & Wharton, 1992). A consequence of modernity is the advent of risks arising out of the interaction between science, technology and society (Reason, 1990) as well as the concerns surrounding the accurate identification and management of risks and ensuring that public fears surrounding the same are not proliferated (Horlick-Jones, 1998).

Giddens (1990, 1998a, 1998b, 1999) and Beck (1992a, 1992b, 1999) argued that a push back against capitalism in the latter part of the twentieth century led to the relationship between labour and capital, as well as individuals and the state undergoing significant change. It was paralleled by a shift in cultural and social ideology where claims to universal truths were doubted and science and reason were subject to increasing challenge (Leonard, 1997). The trend continued with the spread of growing risks magnified by globalisation compressing social spaces unlike previous times (Turner, 2001).

Risks have been said to exist in the 'sensory organs of science' (Beck, 1992a: 162). Scientific knowledge and innovation of technologies magnify and often create new risks (Stehr & Ericson, 2013). It is also a concept closely tied to forensic science, and risk management a key aspect of both crime scene and laboratory practice (Findley, 2008; Gardner, 2011). Science was heralded as a great risk-averter, identifying and aiding in the proof of guilt of criminals with once unthinkable precision. Coerced confessions through torture, and police brutality were slowly weeded out to accommodate the practice of scientific reasoning and establishment of guilt by means of evidence that could withstand logical reasoning and repeatable testing. In this context, the practice of crime scene processing and the wider forensic sciences was the antithesis to miscarriages of justice and the breaches of human rights that had once epitomised law enforcement (see Chapter Two).

Risks are a concern at the forefront of crime scene work. Human-error underlines these risks (Saks & Koehler, 2005), which include contamination, evidence tampering, planting of evidential artefacts, and missing or undetected evidence (Dutelle, 2011). Efficient and result-yielding forensic science begins at the crime scene. However, ascertaining whether a crime has occurred is not always a clear-cut prospect. The decision (arriving at, and demarcating a crime scene) is most often the responsibility of first responders such as uniformed police officers. Emergency services personnel (paramedics and fire officers), health workers (general practitioners, doctors, nurses, staff in hospital emergency departments) or welfare workers (child protection workers and social workers) can also be first responders, but their training in crime scene awareness varies across the board.

There are clear risks to misjudging or misidentifying a potential scene (Julian & Kelty, 2015). For instance, if a crime scene is not identified and cordoned off immediately, the protocols for sealing and keeping it free from contamination will not be followed. The integrity of the scene, quality of the physical and trace evidence would run the risk of being compromised. More importantly, investigators would be unable to use any recoverable evidence or information in order to further an investigation which could lead to a public safety issue or a scenario where justice has not been served. The significance of first responders to establish as early as possible whether a crime has occurred and seal it for scene personnel to process it cannot therefore be overstated (Julian et al. 2012). Efficiency and reliability in crime scene work have significant flow-on effects in the forensic process and justice outcomes (Brown & Willis, 2009; Julian et al., 2011; Kelty et al. 2012).

Junk/pseudo-science (such as hair and bite-mark matching), unvalidated analysis techniques, sample contamination, accidental destruction, wilful tampering or erroneous conclusions reached, are laboratory-specific risks that forensic science has introduced into the criminal

justice system (NAS, 2009a). The wider effect of these risks could be wrongful convictions, unjust exonerations which have the potential to affect the reputation of law enforcement and the justice system leading to less public confidence (Skogan, 2009; Jang et al. 2010) and public unrest.

Policymakers could therefore be interested in minimising these risks and their potential wider consequences by minimising human contact with the evidence in both collection and processing, from crime scene to court. They could also quell fears of misconduct or risk of miscarriage of justice by adopting systems which could appear to be more reliable. Advances in machines and automation has driven forward ideas that may have appeared to be far-fetched in the twentieth century but could be a reality in the twenty-first. Science and technology progressed at a fast pace with innovations since the late 1980s transforming the manner in which society interacts with these facets and vice-versa.

The role of science in modern society became a topic of conversation for sociologists from the latter part of the twentieth century. It formed the basis for the development of science and technology studies (STS). It matured over time, into an interdisciplinary field that introduced an integrative knowledgebase on the origins, dynamics, and consequences of science and technology. The wide reach of the field is encapsulated by the engagement of campaigners, scientists, medical professionals, decisionmakers, engineers, and other stakeholders on matters of fairness, policy, politics, social change, national development, and economic transformation. The importance of the discipline is underscored by discourse in this area having far-reaching policy implications (Hackett et al. 2008).

In broad terms, the possible objectives for engaging the policy process and strategies concerning STS can be summed up as objectives to improve policies that affect science (policy for science) or to improve upon policies that can be bettered through scientific input (science for policy). The discipline can thus make a contribution through information exchange with policymakers about scientific subjects, or by instigating policy outcomes through publication, political pressure or incentivising policy outcomes (Higgins et al. 2006). Innovations in science and technology have transformed the manner in which societies operate, with varying attitudes towards science a staple. However, automation and computerisation has had arguably more effect on modern society than any other innovation. And, it is this subset of technological innovation which draws attention.

The Role of Technology

Technology has encroached upon almost every occupation in the modern world. Machines have consistently been developed to be more powerful, cheaper and easier to use (Frey & Osbourne, 2017). Since the 1990s, employment in Western economies grew in both low and high-skill

occupations, but fell in middle-skill ones (OECD, 2017). Middle-skill, middle-class occupations are those that can be most easily replaced by technology (Wolf, 2014). An illustration is the move towards ATMs and electronic banking to replace bank tellers, and trimming costs (Lee et al. 2003). Airline companies actively encourage customers to check themselves in both online, and at the airport, to save on the cost of maintaining a significant on-the-ground workforce (Lin & Filieri, 2015; Chen & Wang, 2016).

Some jobs have been replaced altogether by new technology, such as electricity meter readers, with the job being undertaken by smart machines (Gandhi & Bansal, 2013). Police sketch artists, considered to employ a forensic technique to ascertain the likely appearance of a suspect, are losing their livelihood due to many police departments producing digital composite sketches on computers by using software that any officer can be trained to operate (Valentine & Davies, 2015). Robots and rovers have been used for the purposes of bomb disposal for decades (Beltrán-González et al. 2007; Sharkey, 2008). These added to the existing fear that technological advancements would negatively impact labour markets and make employees redundant (Rifkin, 1995).

The impact of such technologies in crime scene work is a relatively unexamined subject, but as scene practitioners have traditionally been said to just 'bag and tag' evidence — a phrase used by law enforcement personnel to often marginalise the contribution of scene examiners to the overall investigation process, and conventional commentary stating that there is little skill in scene investigation, the question arises, could a machine do the work of a trained crime scene examiner?

Criminal Investigations without Scene Practitioners

The idea that scene practitioners are perceived as expert collaborators in some forces, and as technical assistants to police investigators has been formulated and repeated (Williams, 2004; Williams, 2007; Julian et al. 2012). The expert collaborator designation was argued to be based on the relevance of unique knowledge-based experiences which made them structurally integrable into investigations, while technical assistants were thought to be capable of providing important technical information to the investigative team but required more senior members to corroborate the input (Williams, 2004). In each context, the value of the work is clear — scene work acts as the vital link between physical evidence collection, analysis in the laboratory and use in investigative efforts and subsequently in court.

Their importance can be conceptualised through a simple supposition. If one was to imagine a world where crime scene practitioners were non-essential to the criminal investigative process, and took them out of the process completely, would it make any difference? In an ideal world where money was no issue and resources were unlimited, there would be no need for competent

crime scene practitioners to process scenes. Any person with reasonable motor skills and object avoidance, could conceivably just bag and tag every single item inside a potential crime scene and ship it off to a multitude of forensic scientists waiting to contextualize, and analyze the items recovered. In this idealized scenario, the person tasked with collecting the items is theorized to be incapable of contaminating or compromising the integrity of the collected artefacts.

The main issue however, even in these stipulated circumstances, would concern the amount of time and resources spent in separating the evidence that is relevant to the case, from merely items which have no connection, significance or bearing on a potential criminal prosecution. The forensic scientists would be tasked with trying to piece together which item was recovered from where, and whether or not it was of any evidential value, based on labels on the items, and/or if any documentation was undertaken at the time of the items being collected. In order for the forensic scientists in the lab to have any reasonable chance of separating potential evidence from merely objects of no relevance to the case, the person tasked with bagging and tagging, would need to be reasonably skilled in documenting where the item was collected, and its location in relation to other items at the scene.

The next challenge would be, deciding which surfaces to dust or swab for biological traces. If there was any footprint evidence, the floorboards, tiles or any other ground plane would need to be pried open and brought back to the lab for testing. As far-fetched as the scenario sounds, with unlimited resources, and an endless line of forensic scientists waiting to work on just that case, with no time restrictions, or pressures from law enforcement and/or the prosecution, this set up, though with a great amount of difficulty, could conceivably work. However, each of the stipulations made would be impossible to ignore or avoid. Resources are limited, forensic scientists usually work dozens of cases at the same time, there is more often than not restrictions on time, and scientific support is a high-pressure undertaking.

Costs and value-for-money service are mentioned constantly in literature as a basis to determine the worth of crime scene work and its practitioners (Jamieson, 2004; Pepper, 2010; Fish et al. 2013; Wilson-Kovacs, 2014; Robinson, 2016). There have been suggestions that changes to organisational, scientific and technological paradigms since the late 1980s have affected crime scene work, and its practitioners. Staffing levels and resource allocation have been issues of concern for years because of these changes (Williams, 2004). If a machine were to assist in or take up the role of a crime scene practitioner altogether, then it would need to be able to process complex tasks in complex settings, and at an affordable price. It could also have potential implications of deskilling and replacing existing personnel, while even reshaping the forensic science workforce as a whole.

The Automation Debate

There is continuing debate surrounding the effect of automation and work reorganisation practices on workers, and in turn society. Countless works have been devoted to both support and refute the central argument put forward by Braverman (1974) that the inclination of modern or late capitalism is to seek control of the labour process through the deskilling of work (Wood, 1982; Littler, 1982; Thompson, 1983). Braverman (1974) echoed Karl Marx by maintaining that workers do not sell their labour to the capitalist but only the capacity to work (Attewell, 1987; Littler, 1990).

It was argued that the role of management under monopoly capitalism was to translate this into actual work performed to extricate surplus value or profit. Management was claimed to be consumed with the search for control over the labour process and utilise work organisation practices based around the division of labour to achieve this aim. Control was gained through the reorganisation of work into low skilled occupations from which the conceptual element was removed and taken over by management. It was argued (Littler, 1990) that Braverman assumed that monopoly capitalism entailed extensive job fragmentation and work specialisation across industries and that the element of deskilling was the primary impetus behind job design(s). This disintegration of work and the concentration of control in management's hands was argued to have been achieved through the implementation of scientific management principles, supported by the increased use of machinery within the production process.

Critique of Braverman's views focused on several facets of his theory but it was his focus on deskilling (and specifically that deskilling is the dominant tendency within the capitalist structure) that was seen as the principal matter of dispute. Jones (1982) and Wilkinson (1983) were critical of the universal and deterministic approach adopted by Braverman and his followers with regard to the consequences of adopting new technology and its impact on skills. Thompson (1983), supported the Braverman supposition of deskilling, but interpreted this only as a tendency within the labour process; something that was indicative of management's desire for change and inclination to control the labour process, at the same time rejecting the general suggestion that such deskilling is inevitable.

Studies have examined the effects of new technology introduction into workplace settings (Wilkinson, 1983; Buchanan and Boddy, 1983). They indicated that technological change can be implemented without the seemingly necessary deskilling taking place. The studies did not contradict the deskilling theory but stated the significance of managerial choice when instigating technology change and in determining the effects on quality of work and levels of productivity (Wall et al. 1987). These were driving forces for a movement in the past four decades to adopt and implement technological change in working practices across industries.

Towards a Technological Society

Robots and advanced automation became embedded in manufacturing processes since the late 1980s, following on from the industrial revolution in the nineteenth century. Society's move towards a more mechanised manufacturing process was characterized by a symbiosis between fast technological progress and the welfare of the workforce. The improvement in machines lent to the increase in productivity of the workers operating said machines leading to more value being attached to them and allowing them to demand higher remunerations. The same workers, in turn, went out and spent their ever-increasing incomes, further driving demand for the products and services they were producing.

However, fewer people worked in manufacturing in 2013 than in 1997 (Rotman, 2013), despite the industry growing exponentially in the period (World Bank, 2018). One reason for this, is that processes once handled by humans have been transformed by industrial robotics in the 1980s using autonomous machines. In the U.S., the number of people employed in manufacturing was 8 million in 1910 and 12 million in 2015 (Bureau of Labor Statistics, 2016). While employment in manufacturing grew over the past 100 years, employment in other industries grew more. The service industry also underwent a similar transformation (Collier, 1983) and it is predicted that the future could be even more precarious for service workers (NCCI, 2017).

Studies have predicted that as many as 800 million jobs could be lost worldwide to automation by 2030, with 5 percent of current occupations completely automated if cutting-edge technology is widely adopted, while in 60 percent of jobs, one-third of activities will be automated (MGI, 2017). Predictions also state that high-paying creative and cognitive jobs will be at a premium, while the demand for middle and low-skill occupations will decline (Carr & Wiemers, 2016; Associated Press, 2016). Crime scene personnel can be said to fall in the latter category, if forensic scientists are considered to be high-skill, with limited-trained police personnel collecting evidence being low-skill. Roles ranging from high-tech crime forensic investigator, to scientific support officers and even scientific support supervisors in Northumbria Police were found in Chapter Five to fall within Grades C to G which were on the lower end of the scale going up to Grade K. The salary ranges were £18,048 to £29,601 p/a. This supports the supposition that crime scene personnel can be categorized as low- or middle-income workers. It is therefore imperative for the welfare of the vocation to examine the susceptibility of scene personnel to automation.

Under austerity measures, cuts to resources and staff numbers are common. The idea behind the cuts, while rooted in economics, also underlines the move towards a more technological society where the power of artificial intelligence can do what people had done in the past. As they have

the potential to directly affect the livelihoods of workers and their families, mechanisation is often touted as a synonym for modernisation. Benefits such as convenience and efficiency are also presented as desirable trade-offs to automation.

In Chapter Five, it was found that crime scene practitioner numbers fluctuated year by year in the UK over the six-year period from 2009-2015, and that trend could shift further as austerity measures coupled with the decision to leave the European Union (EU) have led many to believe that the future is uncertain for UK workers across all vocations (Jessop, 2017; Knight, 2017). In the age of austerity, balancing the books and lowering national debt have been argued to have taken precedence over the protection of the welfare state (Zweiniger-Barcielowska, 1994; Lowndes & Pratchett, 2012). Cuts to police numbers and resources have been constant in the UK, with violent crime (knife and firearms) showing a recent spike (Office of National Statistics, 2018). While there could be a correlation between decreasing police numbers and a statistical rise of violent crime, there is no empirical basis to claim causation. However, the formulation of a technology-focused strategy to combat crime could be a worthwhile venture in a climate of austerity for several reasons, most importantly as a measure of cost-cutting and efficiency.

Artificial Intelligence and Modernisation of Work

Technology has often been cited as a means of increasing efficiency and compensating for decreasing numbers of human workers (Daugherty & Wilson, 2018). From a largely dominant industrial focus, the field of robotics and automation has been rapidly expanding into human environments and is vigorously engaged in its new challenges. Interacting with, assisting, serving, and exploring with humans, emerging systems are increasingly touching people and their lives. Algorithms are able to take in and analyse massive volumes of data to inform and remotely-control environs, make better management decisions, and reach more efficient outcomes (Grace et al. 2017).

Modern computers are capable of storing, organising, fetching and processing huge volumes of data. It has proven useful for tasks such as e-commerce where potentially millions of products are inventoried for sale and restoring health records of billions of individuals for fast access by doctors. Contemporary systems have evolved from retrieving and displaying data into making decisions about data - a function attributed to machine learning algorithms. Computers possess the capability to learn from data and then make predictions and decisions based on that data. Programs with this function often answering seemingly routine queries like, whether an email is junk/spam, whether a person's heart shows the sign of cardiac disease, song predictions on internet radio apps, and video suggestions on streaming websites.

Modern robotics is much more than bearings, cams, clutches, gears, shafts, and springs. Despite typically sharing common characteristics such as manipulators (arms), end effectors (hands), a controller, a power supply, and an array of sensors to provide information about the environment in which the robot must operate, advanced machines are equipped with a mind of their own. Artificial Intelligence (AI) made extraordinary progress since the late 1990s, due to a versatile technique called "deep learning". From neural networks, machine intelligence, computational intelligence, expert systems and evolutionary and computational intelligence the emergence of AI as a competitive advantage grew across all industries. Given enough data, large (or "deep") neural networks, modelled on the brain's architecture, can be trained to do a multitude of functions and tasks. This is the core technology behind drones, robotics, weapons, medical tech and self-serving vehicles, powering Google's search engine, Facebook's automatic photo tagging, Apple's voice assistant, Amazon's shopping recommendations and Tesla's self-driving cars.

Programs such as these would often not be described as intelligent in the same manner human intelligence is quantified or conceptualised. Commentators describe machine learning as a set of techniques that furthers a move towards artificial intelligence (AI). Machine learning and AI algorithms are sophisticated to the extent that without a conceptual understanding of its algorithms, it would be difficult to contextualise for crime scene purposes.

The most effective example to illustrate the possible mechanics of a machine processing a crime scene would be to task it with the identification and classification of blood evidence. Studies have shown that the interpretation of blood evidence is a highly subjective endeavour where opinions are prone to change with slight alterations or updates to contextual information (Osborne et al. 2016). Blood evidence is an important forensic tool in identifying and locating suspects using typing, and DNA technologies. Injuries and/or wounds can leave substantial clues as to direction a suspect may be travelling and the seriousness of the wounds. Crime scene traces such as these can point to suppositions that a suspect may have sustained an injury allowing for investigators to alert local hospitals, emergency rooms, and urgent care facilities to be on the lookout. Blood trails can indicate whether a suspect entered a vehicle if it disappears near an alley, highway, or street. Spatter patterns can be examined to ascertain types of impact and injury. The height and distance of blood spatter can be used to recreate the crime scene with 3D rendering software. However, the issue to consider is whether modern computer systems are capable of autonomously undertaking evidence processing at crime scenes.

Pattern Recognition Through Artificial Intelligence

An example of a seemingly simple decision of whether an observed bloodstain is a directional blood drop, or a spheroid gravitational blood drop can demonstrate the complexities of machine

learning and its operations and scope. The decision process is called classification and the algorithm, a classifier. There are several ways and techniques by which data for training a system can be utilised, such as photos and videos. However, many processes reduce the complexity of real-world objects and phenomena into features - values that characterize the objects that need to be classified.

For the purposes of this example, two features (shape and directionality) are sufficient for explanation. To train the machine learning classifier to facilitate accurate predictions, training data is required. The system begins with initial data, such as those collected in the field from a crime scene investigator. The recognition data containing the characteristics of the two types of bloodstain are recorded and labelled. The data can then be visualised in a scatter plot. Data from as large a sample as possible for both bloodstain types is entered into the system and the result will yield two groupings.

There will be some overlap in the middle of the graph. Machine learning algorithms then engage in what is known as optimal separation. The system separates the data based on decision spaces called decision boundaries. This is likely to result in groupings with a certain percentage of error. Some of the stains will be correctly identified, while others will fall outside of the decision boundaries for each individual stain pattern classification. The correct and erroneous data is recorded in a table called a confusion matrix.

High level machine learning algorithms maximize correct classifications while minimising errors based on training data. The initial cycle is likely to yield a high percentage of correct conclusions and using the established decision boundaries if new unlabelled data is introduced into the decision space, the unlabelled data can be plotted within decision boundaries offering a guess as to the blood evidence type.

The approach of dividing the decision space up into boxes can be represented by a construct known as the decision tree, which would could be written in code using IF, THEN, ELSE statements (Margineantu & Dietterich, 2003). Machine learning algorithm that produces decision trees is required to select the features to divide on (like branches) and therefore each of those features what values to use for the division. Algorithms can also utilise multiple decision trees working together to make predictions. Non-tree-based approaches like support vector machines can also be used. It is the machine learning algorithms that are tasked with figuring out the best lines to provide the most accurate decision boundaries.

In cases where there are multiple features, the scenario somewhat changes. If a third feature, such as size of the stain was introduced, then the existing 2D scatter plot becomes a 3D plane where decision boundaries are created in three dimensions. The planes do not have any requirement to be linear. The most effective classifiers would contend with many different

blood evidence types. If more features are added though, they would not be possible to visualise pictorially, or by hand.

Many real-world machine learning problems are tackled using equations for a hyperplane consisting of thousands of dimensional decision spaces. Modern computers with intuitive machine learning algorithms are capable of undertaking astronomical calculations using processing power which was not possible in the 20th century.

Google, Facebook, Microsoft and Amazon utilise techniques such as decision trees and support vector machines in their daily business (Bekkerman et al. 2011). Their systems are strongly rooted in the field of statistics which is required in order to reach confident decisions using existing data.

There is a wide variety of statistical machine learning techniques and others with no origins in statistics. The most important of the latter is artificial neural networks, which were inspired by neurones in the human brain.

A.I and Artificial Neural Networks

In simple terms, neurons are cells that process and transmit messages using electrical and chemical signals. They take one or more inputs from other cells, process the signals and then emit their own signal. These form massive interconnected networks which are able to process complex information much like the human brain.

Artificial neurones are very similar, each taking a series of inputs, combining them and then emitting a signal. They are not electrical or chemical signals, rather they are artificial neurons that take numbers in and release numbers out. They are organised into layers that are connected by links forming a network of neurons, hence their name. Each node takes in a set of inputs, applies weights to them, and calculates an output value. By chaining together lots of these nodes, complex functions can be modelled.

Even though neural networks were conceived in the 1970s, deep neural nets only became practical after the new millennium (Ma et al. 2015). The reason for this is innovation in powerful processors and faster graphics processing units. Google and Facebook demonstrated deep neural nets that could find faces in photos as well as humans. Following that success, deep neural nets were implemented in self-driving cars, translating human speech, diagnosing medical conditions, and much more. The algorithms are sophisticated but describing them as intelligent might be misleading. They can only really do one specified task such as finding faces or translating languages, meaning their designation should be either weak AI, or narrow AI.

They might only be intelligent as far as specific tasks but are useful with regard to the application and effects of those tasks. For example, medical devices that can make accurate diagnoses, cars that can drive themselves, and systems that are capable of categorising species of insects fulfil useful purposes. It is a little more complicated when the same systems are tasked with composing music or cooking up a meal. General purpose AI, in the truest sense would need to be smart and well-rounded as a human and is referred by commentators as strong AI. Real-world results are yet to demonstrate anything close to human-level artificial intelligence, and some have argued that it may be impossible to achieve. And, while a strong AI is preferable for the processing complex spaces such as crime scenes (see Chapter Three), machines provide distinct advantages in learning and experience-building than humans.

The explosion of digitised knowledge centres such as Wikipedia, indexed pages on search engines, streaming video sites as the input sources for strong AI utilising deep learning. Humans are capable of watching a maximum of 24 hours of video per day, or read 200+ words per minute (Benedetto et al. 2015), but a computer can simultaneously run algorithms that simulate billions of hours of these activities over a fraction of the time in the real world. An example of this is IBM's Watson supercomputer, which consults and synthesizes information from over two-hundred million pages of content including the full text of Wikipedia.

Despite not being a strong AI, Watson is considered smart and it proved as much by beating human competition in the televised gameshow Jeopardy in 2011 (Ferrucci et al. 2013). Modern AIs are adept at taking in large volumes of information and learning over time, much faster than humans. In 2016, Google debuted AlphaGo, a narrow AI that played with dexterity, a complicated board game called Go. Commentators found that one of the ways it gained such proficiency beating very best human players, was by playing the game with itself millions and millions of times in internal simulations. It learnt what worked, what would work and what did not. The repeated exercise resulted in the discovery of successful strategies all by itself. This is the future of AI and has been referred to as reinforcement learning. This powerful approach shares similarities with how humans learn.

If human learning is examined from birth, it can be found that they don't just automatically acquire the ability to walk without the thousands of hours of trial-and-error to figure it out. Modern computer systems are developing this learning by trial and error and for many narrow problems, reinforcement learning is already widely used. The question for the future would concern whether such learning techniques can be applied more broadly to create human-like strong AI’s which learn in the manner students of forensic science learn the craft — only at super-accelerated speeds. The entire knowledgebase of forensic science and crime scene work stored on the cloud, and accessible at lightning fast speed, with no memory lapses or recall

problems opens up possibilities for potentially error-free investigation of crimes. But, just how feasible is this?

Object Recognition at Crime Scenes

The above principles can, though in a limited capacity be utilised to recognise as discussed, patterns in blood evidence, and even entire crime scenes. Blood drops, stains and splatter patterns are routinely photographed in crime scene work. These are usually included in the case file and stored. For machines to learn the various forms blood can take, and its individual labels, a database would be required containing all the possible variations. As before, a classifier algorithm would then be tasked with sorting and determining the samples.

Neural networks take numbers as inputs by aligning numbers in a grid in the shape of the image based on the shade of each pixel. These networks have two outputs: (1) predicts the likelihood that a given image is a certain type of blood evidence; and, (2) predicts the likelihood that is not a specific type of blood evidence. Such a classifier would allow for the different inputs to be sorted and grouped. As in the previous example, images of blood evidence, and those which are not blood evidence can be fed into the system, assigning weights and probability figures to each image for the system to train itself to the data. Training would allow for the fast and accurate recognition of such evidence, as well as correlate similar evidence characteristics for unsolved and ongoing cases in the same, and even different shared-data jurisdictions.

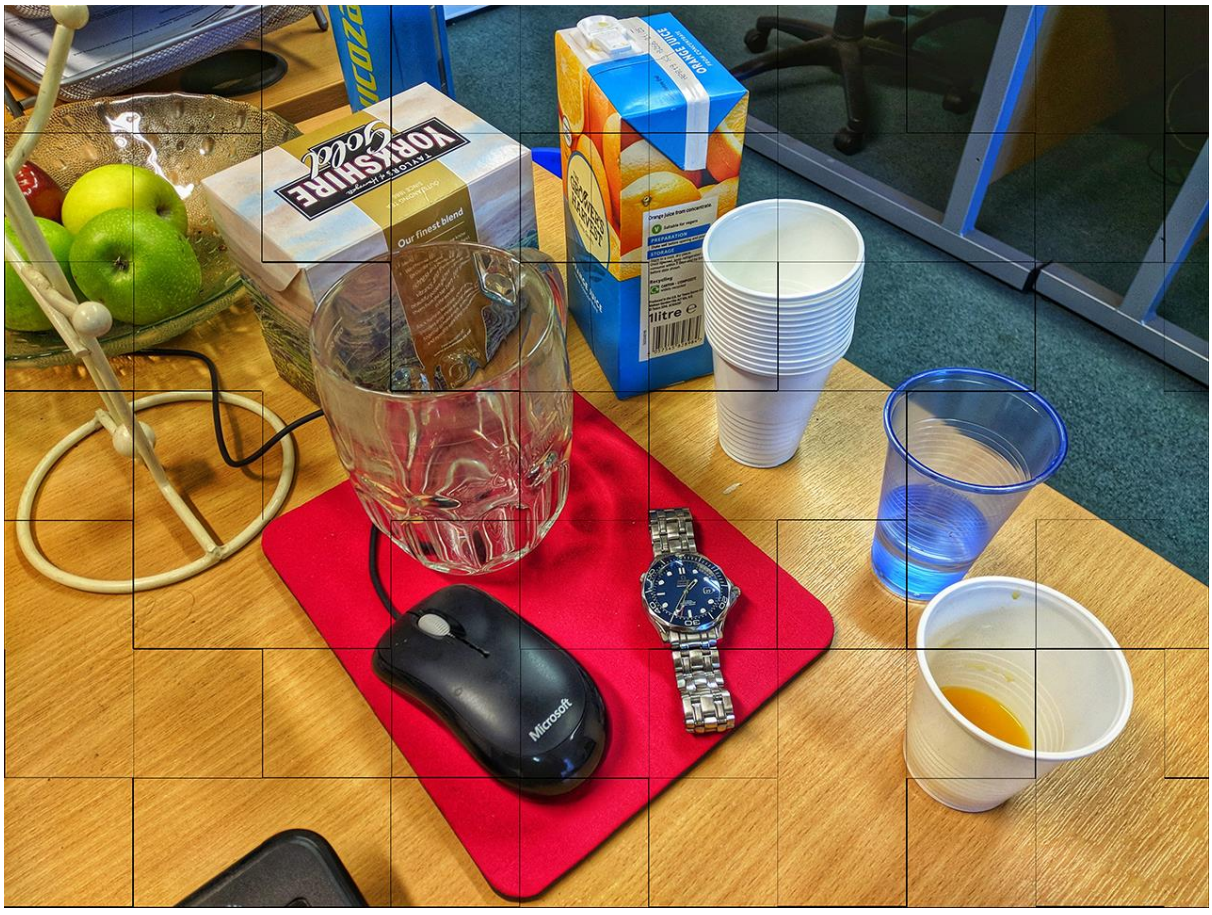
Training data would need to be of varying qualities and from various sources in order for the system to have on record a seemingly endless stream of data to learn from and get better. Bigger neural networks learn faster and can solve complicated patterns. To do so, stacking layers of nodes to form deep neural networks would be ideal. This effectively would allow more computations to occur concurrently at an expeditious rate.

If the objective of computational scene analysis was to go a step forward and recognise other objects in a scene other than just one type of artefact, i.e. blood evidence, a process called convolution would be required. Humans are able to ascertain the hierarchy in pictures by isolating different objects in the foreground and background. In a simple example, the photo below illustrates:

- A flat, brown textured surface with various objects on it
- A transparent, reflective mug, a wired computer mouse and a stainless-steel band watch on a scarlet mousepad, which is itself resting on the brown textured surface
- A stack of empty, white plastic cups
- A white plastic cup with yellow liquid inside
- A carton of orange juice
- A transparent bowl with apples on it
- A box of tea bags
- A metallic stand

These objects are some on the primary surface (flat, brown, and textured) and others on a secondary surface (scarlet mousepad) resting on the primary. Regardless of the surface, the human mind can sort through the objects and create an inventory. Each of these objects has specific characteristics and one could argue that the human brain could identify these objects no matter where it sees them. In computational models, this function is known as translation invariance, which means an object is an object no matter where in a picture it shows up. This would be especially useful in identifying objects at crime scenes and creating inventories of items and their observable state during the investigation. Manually doing this usually would require time and energy which could potentially be minimised through AI intervention.

In machines, the function is achieved through a process called Convolution. The idea driving convolution is that instead of inputting full-scale images in their entirety, and translating them into one grid of numbers, breaking the images into overlapping images as tiles would ensure that the system interprets objects as it is, no matter where it appears in a picture. Each image would then be input into the neural network as a single tile, where the network would process each tile at least the number of times as the amount of tiles. The weights of each tile are maintained the same so as to allow the network to process them with equal importance. The results are then saved from each tile into a new array (a grid with the same arrangement as the original image).



Using the more manageable smaller images as arrays, they are then taking each of the tiles where a possible object appeared and saving it as a pooled array with just those bits with the maximum information. The data is then input into a new neural network which makes the prediction. The entire process is scalable and can be combined and stacked as many times as required, based on the complexity of an image. The system is however, dependent on the human principles of experience, where the more images the AI can analyse and train from, the better its predictions.

Attinger et al. (2018) produced a data set of bloodstain patterns for teaching and research in bloodstain pattern analysis which could be beneficial for blood evidence training in computational systems. However, the set only contains 61 scanned blood spatter patterns. In comparison, MNIST, a dataset of handwritten digits and contains a training set of 60,000 examples and a test set of 10,000 examples. MS-COCO, an object detection, segmentation and captioning dataset has 1.5 million object instances, 330K images and 250K people with key points. CIFAR-10 boasts 60,000 images of 10 classes, 50,000 training images per class and 10,000 test images covering a wide range of objects.

Therefore, in comparison the available dataset for crime scene work is extremely limited and should arguably be increased. Due to overriding privacy and security protocols, any crime scene datasets would unlikely be available to researchers as free or open-source formats, their scope and utility would be restricted. A way around privacy concerns could be to anonymise the data, simply labelling them in terms of their characteristics with any and all case data removed.

Police forces have been found to run pilot studies in order to alter resource levels, change organisational practices or introduce new technologies from time to time. However, in the absence of any knowledge-sharing regime, the results of any findings are rarely shared with other organisations (Williams, 2004). This has been said to impact future decision-making as to the usefulness of specific strategies or technologies which could potentially be effective for other forces. The outcomes of studies of one organisation therefore play a passive role in the shaping of policies for another. The result is a major hurdle in formulating resourcing and management strategies specific to scientific support units and their work, potentially affecting the value and outputs stemming from these units.

Cooperation regimes would therefore be required in AI is to become a part of crime scene investigations in the future. As a consequence of the lack of proper information-sharing or independent research by police organisations, the development of forensic science and criminalistics programmes at academic institutions are traditionally the main source of scientific and technological development in law enforcement scientific support. The importance of such institutions to demonstrate forensic applications of existing scientific principles or discoveries, and emerging technologies cannot be understated (Sensabaugh, 1998), and their role in the shaping of an AI-powered future is therefore critical.

Criminal investigations could still benefit from computational systems which can use publicly available or specialised datasets to match objects at crime scenes, such as footwear patterns to find the brand of a shoe, or tire marks to identify the make and model of a car. Leveraging

artificial intelligence in forensic intelligence systems could therefore add value to criminal investigations.

Beyond image processing, artificial intelligence holds the potential to also correlate crime scene behaviour of suspects and link potentially connected crime scenes. Crime scene behaviour is a valuable resource for investigators to construct suspect profiles in major crime events (Douglas et al. 1986; Homant & Kennedy, 1998; Alison et al. 2002). However, for non-image-based computations (non-vision applications) and using object detection to make key decisions at a scene, the system would need to adopt the ability to contextualise information and rationalise its own decision-making.

Crime scene work (due to the chaotic nature of scenes [see Chapter Three]) relies on complex reasoning skills and the ability to distil a large amount of information in order to make quick and well-reasoned decisions (Baber et al. 2006; Pepper, 2010; Shaler, 2011). Human reasoning far surpasses the limitations of logic or inferences made from logic. Reasoning can refer to the conclusions derived from inferences taken from information (Evans, 2002). When scene examiners view a scene, they simultaneously sort through the various items that have a high probability of being evidence, the items at the scene which are potentially not relevant to the case (as such, not evidence for documentation/collection), strategize the most effective means of moving around through the scene without disturbing the evidence, prepare efficient methods for documentation and collection, as well as plan for the transfer of the same to the laboratory.

While processing power may not be the bottleneck that holds a robot crime scene investigator back, its abilities of contextualisation, rationalisation and logic-based reasoning in crime scene spaces could prove a challenge. The simple act of watching a short video on social media causes the human brain to separate various objects in the video, infer context from speech and actions, and derive meaning of the sequence of images projected across the screen. The number of logical propositions and inferences is astronomical (Anderson et al. 2006). Such cognitive tasks pose a challenge for artificial intelligence systems.

There are every day uses of language which illustrate the significance of context in artificial intelligence. An utterance of the phrase ‘get out’ in a social setting between friends can have a completely different implication than if a bartender shouts the same words at a drunken patron. The same applies where one person says to the other ‘I will kill you’ as a response to friendly ribbing, and another situation where a person runs up to another and says it in reply to a derogatory statement about a parent. Context is therefore vital (Nilsson, 2014).

A simple computer language expression (Microsoft, 2018) can illustrate a possible conundrum.

X is Evidence Type;

Y is Decision;

IF x= BLOOD THEN y = COLLECT;

Therefore, if the evidence type found is blood, then the decision would be to collect it. However, if the blood stain is in a slaughterhouse, then merely collecting blood would not yield the desirable outcome of a scene investigation. The expression would need to be amended, in that:

IF x= HUMAN_BLOOD

THEN

y= COLLECT

ELSE

y = DO_NOT_COLLECT;

In the example, the computer would need to know what is meant by blood, what is meant by human_blood, and what the expression outcomes collect, and do_not_collect signify. Essentially, it would have to learn each of these variables and what to do in case each is introduced in the algorithm.

Crime scenes are complex spaces with innumerable variables and possibilities. Scene practitioners will often look for objects or traces which may seem out of place at a crime scene (Millen, 2008). It is the unusual and out-of-the-ordinary that yield suspicion and drive investigation forward. If an AI-powered robot were to perform reasoning tasks, it would require a large repository of knowledge, in combination with historical record of crime scene practitioner preferences and decisions, location-based or case-based changes to standard operating procedures, situational context, and the data from the machine's own sensors when at the scene. These principles were applied on a limited scale to illustrate the possibilities of robotics and AI in scene work with specific focus on scene documentation (Chowdhury, 2016).

AI-Assisted Crime Scene Work

However, the state of AI at the time of writing has not yet developed to the scale or scope to mount any serious challenge to human crime scene practitioners. AI could however be a useful tool in a crime scene worker's arsenal. Depth-sensing cameras equipped with smart software, such as those in Google's Project Tango prototype could provide an alternative to manually sketching crime scenes, by recording an accurate representation of the scene with pinpoint measurements and even picture-perfect 3D models. Google claimed that Project Tango was able to view physical environments using sensors through a combination of three core

functions. Motion tracking, which allowed it to understand its position and orientation using a range of sensors (including accelerometer and gyroscope), depth perception, which examined the shape of objects around it and using a proprietary 3D camera plus component board, rendered 3D objects from the images that it recorded. Finally, Tango incorporated area learning, meaning it mapped out and remembered the physical space around it, calculating both distance between itself and each object, the object's size, and where it sat in relation to other items in the area.

While these innovations and the promise of AI can lull visionaries and even policymakers to dream of the technological future where artificially intelligent crime scene robots process crime scenes on their own accord, efficiently and at a fraction of the cost of human scene practitioners, the nuances and complexities of crime scene decision-making may prevent that future from manifesting itself anytime soon. Systems such as those described in this chapter, can do extraordinary things that only if functions are set out and actions occur sequentially. Due to the nonlinear nature of crime scenes, conventional wisdom would dictate that in nonlinear function process would be required for any meaningful engagement of artificial intelligence with crime scene environments.

However, the biggest hurdle subsystems can have is the unequivocal declaration by commentators that crime scene investigation cannot be achieved by following any checklist and that each scene is sufficiently different for any standard operating procedures to be merely suggestive than prescriptive. Crime scene investigation relies more on skill, dexterity and communication than any dependence on technologically mediated apparatus (Williams, 2008) and as such, their worth can only increase with time, and policymakers should protect the discipline and its practitioners from being marginalised.

CONCLUSION

Mechanisation of working practices in both the manufacturing and service industries have prompted debates about the possible futures of occupations where the human element is considered to be non-essential. In times of austerity, such questions are fuelled by a desire to cut costs and balance the books. Despite being a middle-income occupation, crime scene work and its practitioners could be somewhat safeguarded as their functions are much more aligned with specialised skill occupations which are harder to replace. The nuances and complexities of crime scenes, and their subjective nature ensures that even though AI, in its present state could make predictions on objects found at a scene, its decision-making would depend on large volumes of well-labelled digitised data of crime scenes, and decision-making instances at the same. Development of such systems would be highly dependent on cooperative regimes between law enforcement organisations for knowledge sharing and information pooling.

The lure of a technological society where machines minimise human error has led to mechanisation and automation of several occupations, some even leading to human intervention becoming obsolete. Mistakes in investigation, and subsequent misinformed judgments have come into focus recently with DNA exonerations and more robust means of evidence collection and analysis. Faith in machines as less error-prone than humans might advance measures to use artificial intelligence instead of crime scene practitioners to process evidence. The aversion of risks, such as evidence tampering, contamination and manipulation (as discussed in the previous chapter) could be motivators in this move. The solution is not as simple as just handing over the reins to a machine, though.

It would not be inaccurate to describe AI in the field as being in its infancy, as the experience (training data) it would require becoming functional is still years away. Awareness of the role and contribution of scene examiners and the negative effects of replacing them would need to be communicated to policymakers and the law enforcement administration so that well-informed decisions can be made to improve technological innovation in the area, without jeopardising quality.

Crime scene practitioners have a higher risk of being replaced by law enforcement personnel being asked to undertake dual roles as either first-responders and crime scene workers, or crime scene tasks being assigned to investigative members of staff, such as detectives. This would ultimately come down to a cost-benefit analysis on an organisational level, as Chapter Five illustrated that there is no uniformity in policy in England & Wales regarding crime scene work. The move towards a more efficient and quality-driven scene practice culture would start with adoption of homogeneous and scalable policies which can aid emerging technologies such as AI and robotics grow, in conjunction with investment in human scene practitioners and the organisational mechanisms that can propel the discipline to its true potential.

CHAPTER EIGHT

At the beginning of 2019, the House of Lords concluded that forensic science in the United Kingdom was in crisis and that urgent reforms were needed to move forward (House of Lords, 2019). This thesis began with an exploratory approach to the state of forensic science in the UK, and the findings have not refuted the assertions made by the respective reports by the House of Commons, and the Lord's. The state of the discipline has seen significant decline in the past decade due to the closure of several quality assurance, and state-run bodies such as the CRFP and the Forensic Science Service (FSS). These cost cutting measures by the government has seen concerns about the quality of service increase over time, placing a significant burden on the private sector to fill the vacuum. At the heart of the crisis lies a lack of funding and statutory powers for the forensic science regulator, and the absence of state regulatory frameworks which can guide forensic science innovation and research forward (House of Lords, 2019).

One of the most striking findings of the thesis was the lack of understanding of what a crime scene is, can be, and its conceptual basis. Notwithstanding the substantial gaps in knowledge, in the history of crime scene investigation, and the legal, political, cultural and social developments which contributed to the enactment and growth of the forensic discipline, the organizational pillars of the same as examined in Chapter Two. It highlighted the need to acknowledge the importance of strong legal infrastructures with cultural and social acceptance of scientific practices to resolve criminal matters. Scientific thinking, can be traced as a direct proponent in establishment of new and innovative measures to combat and solve crimes since the Middle Ages in the Far East, however, due to cultural, political, social, and legal factors, these principles could not be integrated into the criminal justice system in the West, until the 18th century. The barriers to integration of scientific knowledge into the legal system was also examined. The underlying conclusion of the findings was that there is seldom an alternative to logical thinking when it comes to crime scene investigation, and forensic science.

Personal conversations with the FSR on 7th May 2019 at Northumbria University as part of a lecture delivered on the House of Lords report and the way forward for forensic science in the UK, highlighted the need for the implementation and maintenance of the scientific method across the board in every forensic discipline, including crime scene investigation. Testability and oversight were key aspects mentioned. The inherent difficulties in ISO standardisation of crime scene work was also communicated to the author of this thesis by the FSR, with alternatives to body cameras discussed. The FSR’s comments, the Lords report and the lecture itself lent critical context to this thesis and highlighted the lack of attention paid by all aforementioned bodies to crime scene practice.

The Lords report mentioned crime scene work less than ten times in a report that spanned 66 pages, and over 25,000 words. The FSR herself only mentioned crime scene investigation in passing in her lecture, and looking back, the House of Commons (2016) Forensic Science Strategy document only referred six times to crime scene practice and/or its practitioners. The problems with quality assurance and competency standards are repeated in each of these reports without a roadmap for change. This thesis identifies and elaborates on these aspects and more, providing detailed recommendations in each chapter. A summary of the thesis findings and recommendations is presented below.

OVERVIEW OF FINDINGS

This thesis examined the general facets of crime scene work in the United Kingdom, with particular emphasis on the definition and framing of crime scene practitioners in the broader criminal justice system. Through analysis of practitioner numbers, law enforcement spending on scene work and the roles, responsibilities and expectations of law enforcement pertaining to scene workers, an overall understanding of the potential size of the crime scene workforce and the investment of the state on the same, was presented in quantitative and qualitative formats. The investigation also recognised the historical events which can be argued to be a precursor to modern crime scene practice, with emphasis on the need for robust infrastructural frameworks for the maintenance of development of the discipline further. Quality assurance (QA) and control (QC) has been stated by regulatory bodies and oversight figures as an essential focal point of forensic science in the UK, and this thesis aimed to develop a coherent and comprehensive picture of the state of QA and QC in crime scene practice. Few texts exist on the subject, and it was charted that the thesis would serve as a guide for policymakers. Critical questions were asked about the bodies involved with quality systems within police forces, the government and the private sector. Recommendations were also afforded for improvement of these systems, and policies which could elevate standards through a system of multitiered accountability across testing organisations, as well as oversight bodies.

The key theoretical models underpinning the thesis encapsulated a defocused look at social constructions of knowledge, enactment of knowledge societies, an evaluation of Marx's theory of history, the shift from traditionalism to modernity, the emergence of the risk society, modernism's effect on individual responsibility, concepts of trust, competence and legitimacy in postmodern societies, the devaluation of skills and competence in postmodernity, the wider culture of neoliberalism and influence of the private sector, an evaluation of the deskilling thesis, and the consequences of enlightenment and modernity, prominently the rise of police administration, knowledge regimes and construction of what constitutes as 'evidence'.

Technological determinism was also a continuing theme in the thesis with such questions as, whether social change drives technological innovation, or if the latter drove the former. The construction of forensic realities by the public, media, state actors, law enforcement, and the courts was also examined. Boundary work's characteristic of commodifying technical evidence amid a move from government to governance through fragmentation of political authority and demonstrable pluralism of security were themes that were prominent in the thesis. The sociologies of work, occupations and organisations played a key role in the study to emphasise the role of postmodernity in conceptualisations of social capital, namely concepts such as legitimacy, trust and competence. The importance of conceptualisation in workspaces in general was emphasised in the thesis, with useful discussion on paradigms and universality.

The thesis also contributed to the wider understanding of police, policing and the state of forensic science in the United Kingdom. It illustrated, using a seldom-used research tool, i.e. freedom of information, nuances of the UK police's role as an information-handling organisation, and the manner in which personnel and performance data is collected, retained and distributed. These are all reflections of modernity and its effect on the organisation and the self, where continuous development to management policies lead to the development of organisational competencies rather than individual competence. These lead to new risks such as the rise in anxiety surrounding possible crime rather than the fear of actual crime. The effect is hard-line criminal justice policies, and the creation of new risks as a result of the interaction between science, technology and society. In criminal justice contexts, these risks can manifest as miscarriages of justice, human rights violations and challenges to state legitimacy. Understanding gained from an occupational science perspective illustrated the value of staff in police organisations to collaborate on investigations using shared expertise, and the specific worth of crime scene practitioners in the field due to their direct interaction with victims, witnesses and the wider community. It was a worthwhile indicator of the way modern societies co-produce social order thorough cooperative regimes and partnerships.

Forensic science can also be a proponent of risk with its effect being a rational, more technical and logical system of adjudication with higher burdens of proof and legal requirements of punishment. An overreliance on science, fragmenting into rogue experts introducing junk/pseudo-science to answer unanswerable questions due to increased reliance on for-profit experts and paid witnesses. The thesis examined in detail the consequences of the devaluation of competence in the forensic sciences, most prominently crime scene work, and charted a trajectory of a modern world where human capital is at risk of being devalued even more due to an increasing dependence on machines and technology, where even junk or pseudo-science cannot answer the call. Insights into the deskilling thesis, and the tie-in with science and technology studies answer valuable questions surrounding the deskilling debate, and whether

social constructions of what traditionally happened, and what should happen can constitute as evidence of what will happen.

The chapters of the thesis were arranged to maximise readability and focused particularly on the framing of crime scene work beyond the traditional definitions. They attempted to cover a broad range of issues in crime scene work, such as the importance of legal, cultural and social factors in the enactment, acceptance, maintenance and development of scientific evidence and practices in criminal justice systems. Through contemporary and historic examples, their crucial role in crime scene work was argued in Chapter Two.

This thesis began with the assertion that modern society is an amalgamation of multiple realities in the context of human perception pertaining to social, political, cultural and legal happenings. Forensic science and crime scene practice are areas where a convergence of reality and its idealised media representation are rare, due to the sensational nature of its reporting, and its portrayal as the one-key-fits-all to solving the most complex of criminal cases. It was not always the case that science was hailed as a methodological framework for analysing criminal evidence. Chapter Two addressed the inherent difficulties religion-driven societies face in establishing forensic science, and the challenges that future societies might face if their legal systems are not conducive to rational and logical frameworks for assessing evidence admission, its political landscape unsupportive of scientific practice, and the misunderstanding or lack of understanding of citizens and policymakers of the value of the sciences. It argued, through a comprehensive retelling of crime scene science history, the significance of education, investment, and acceptance in the forensic sciences, and by extension crime scene work.

One of the principal findings of the chapter was that in order for forensic science to exist, grow and thrive, a number of key conditions need to be present. These include: (1) an evidence-based legal system which does not rely solely on eyewitness testimony, and or confession evidence; (2) a system of adjudication where evidence is obtained in a lawful manner, and those collecting and presenting evidence can be cross-examined by the defence, and their conclusions challenged by independent experts; (3) judicial receptiveness to physical evidence, and their analysis through means which can withstand logical scrutiny; (4) social order where law-enforcement structures exist, and their position as peacekeepers and crime solvers is encased in legislation and accepted by citizens; (5) the political landscape where the value of investment in law enforcement and criminal justice mechanisms is reflected through continued support and understanding of its needs; (6) a culture of accountability across the board, in terms of scrutiny from evidence collection, it's analysis, to its presentation in court; and (7) establishment and maintenance of a robust culture of scientific development, where developed technologies and scientific principles are transferable to be applied to real-world scenarios in forensic contexts.

The application of these lessons from the past can be surmised to be difficult in the current UK approach with regard to forensic science. The closure of support organizations such as the FSS and the CRFP are examples of a lack of investment by the state, its policy short-sightedness, and lack of forward-thinking strategies to improve the standard of forensic science. Financial data collected from police forces across jurisdictions in the UK, indicated a steadily declining level of investment in crime scene work as well as scientific support. Staff numbers also showed regression, with almost all forces facing cuts and lower numbers from 2009 till 2015.

Despite, there being progress in courtrooms accepting scientific evidence for adjudication purposes, a massive gap remains in the understanding of forensic science and crime scene investigation amongst legal professionals, such as barristers, solicitors, and even judges. There is also the issue of gatekeeping for forensic evidence, where bad or pseudoscience evidence is admitted in legal proceedings, such as bite-mark and hair comparison. In one key area, progress has been made. There is widespread acceptance of forensic science and crime scene investigation in society, however the misrepresentation and overestimation of the scope of forensic science as a crime solving tool has been said to create problems in the courtroom where jurors have been found to be influenced by what has been described by commentators as the CSI effect. Technology development and adoption into criminal justice processes has been slow in the UK, according to the FSR and the House of Lords.

The culture of accountability which is critical to a streamlined, and effective mechanism of maintaining integrity of the evidence, is challenging to implement in crime scene perspectives. The vague definition of what an expert is, lends itself to a series of problems in court, where anyone who the court deems to be an expert, can be declared as such, without any set qualifications or standards. While the legal system has developed to be evidence-based, and evidence is given due consideration in most cases, the lack of evidence which qualifies experts to court cases may be most threatening to forensic science moving forward from its dark beginnings almost a millennium ago. The chapter also provided an unique understanding of the development of legal systems and law enforcement apparatus, by using crime scene work and forensic science as a framing device.

Chapter Three examined the crime scene in a new light, by arguing for its analysis to be like a system, rather than a physical space. The value of such a conceptualisation is that systems can be scaled, and its methods and practices adopted for the purpose, so that crime scene work is not reduced to a one-size fits all approach, and its practitioners not thrown into the deep end when exposed to new scenarios and challenges. It also argued for the recognition of crime scenes as complex, dynamic systems were multiple factors (such as temperature, humidity, air pressure, gravity, exposure, and human intervention) can have unexpected effects on evidence,

and human cadavers. Understanding these complexities can work towards reducing the misunderstanding of crime scene work as manual, unthinking, mechanical labour, and moving towards recognizing scene practice as a multi-tiered, analytical vocation within scientific spaces, i.e. crime scenes.

The chapter thus introduced the concept of crime scenes being more than mere physical spaces. It argued for a broader understanding of crime scenes as systems with microecosystems working together and in conflict from the time an act or omission (such as criminal conduct) occurs, its undiscovered period, and subsequently detection and documentation by the authorities. The chapter maintained that there are clear benefits to viewing crime scene work as a system, as systematic analysis could improve planning, performance and development of the discipline. It would also dispel myths of scene work being non-thinking, mechanical work, which could be done with minimal training. The complexities and challenges of scene work, where practitioners contend with evidence degradation, and the chaos of human unpredictability in their quest to piece together the circumstances which led to the commission of a criminal act, could therefore be an informative starting point for police practitioners and policymakers to understand the work done by scene workers and to afford them the resources to undertake their often-downplayed responsibilities.

The chapter proposed that crime scene work is dependent on universal constants, such as gravity, environmental and climate factors. The degradation and/or recoverability of evidence depends on the rate of decay either slowed down or accelerated by these factors, along with human actions or inactions which are less predictable or universal. The principles apply to any scene, anywhere in the world as long as naturally occurring phenomena is recognised and accounted for, when processing a scene. The chaos of crime scenes, as was described in the thesis, is caused by the unpredictability of human action, or, the often convoluted series of actions which lead to a degraded or preserved scene that is unknowable to a scene practitioner due to the passage of time. The process of conceptualising and rationalising is a matter of competence, and hence, the understanding of these dynamics and the chaos of scenes is a necessity, wherever the staff member is practicing the discipline. The phenomenon adds valuable insight into the complexity of scenes and the competence required in order to make sense of them. Framing the discipline as not just one of technical skill, but a concerted scientific endeavour in later chapters is facilitated by the demystification of crime scenes and the unique, dynamic characteristics that require the utilisation of those skills and the scientific method.

Operating in these spaces is a myriad of actors, including first-responders, investigators, medico-legal personnel and crime scene practitioners. The relationships between these actors, having briefly been discussed in Chapter Three become even more important when

contextualising with regard to scene staff. In order to ascertain the numbers of scene practitioners, their roles and responsibilities, and the investment of the UK government during the fiscal austerity period, and any effects, if any, these policies had or could have, on performance, methodological challenges were discussed in Chapter Four, and Freedom of Information (FOI) using national Freedom of Information legislation (FOIL) was chosen. The seldom-used method was investigated through consideration of previous studies employing the method, the challenges the researchers faced, and the overall advantages of using it for this thesis.

FOIL for data collection made the most sense, due to the impracticalities of more traditional means of qualitative data collection means, principally surrounding the number of police forces and the volume of content that was being sought for the thesis. The research questions were tied in with the methods, and the substance of the FOI request was outlined. The chapter also discussed and evaluated in some detail, FOI as a method for sociological and criminological research, as such evaluations were found, through researching this thesis, to be lacking in the available literature. It could serve as a useful reference for future researchers looking to adopt FOIL into their research.

Following the discussion of the methods, the thesis introduced Chapter Five, which laid out the data collection pitfalls using FOI requests. All 45 police forces were contacted via e-mail for the thesis, with replies coming in at varying timeframes, and in differing levels of detail. The major problems faced with FOI was non-response, late response, misunderstood request and as a result being sent wrong data, unlabelled data, raw data without contextual information to make sense of it, and out-of-date information.

Chapter Five was revelatory, in that, it outlined the outcome of the FOI requests and the reasons provided for the refusal of requests or returning incomplete data. The most striking finding of the chapter was that the data management practices of UK police forces was severely lacking, with several Forces refusing to provide data due to either not holding financial data on one or all of the three headers (crime scene investigation, laboratory expenses, overall spending on scientific support). It was found to be due to either police forces skirting their responsibilities under FOIL, or unable to retrieve the data due to technological or management frailties. Forces also provided incomplete data citing changes to computer systems, moving to a new style of data recording, and for not holding a breakdown of scientific spending expenses beyond a general, estimated scientific budget. There were also major differences in the way police organisations stored, labelled and presented data with relation to the same, or similar expense, and even the manner in which scene staff figures, crime scene, laboratory and overall scientific costs were perceived and recorded.

Due to gaps in the financial spending data submitted by police forces across the board, it was difficult to formulate any real trend in the expenses relating to scene work, laboratory expenses or overall scientific support. An indication of the high spenders and the forces on the lower end could be estimated, but overall, the data management efficiency of the forces was the key take away. Police Scotland lagged behind with only two years of data being provided, followed by Police Service of Northern Ireland, and then England. Wales had the best response rate with data provided for every year under one of the headers (overall scientific support costs) by all forces, three out of four for crime scene expenses, and two out of four for laboratory spending.

The headcount and full-time equivalent (FTE) figures provided a general understanding of the size of the overall crime scene staff size of the UK, with a sizeable sample size (37 out of 43 forces in England), with participation from forces in Wales, Scotland, and Northern Ireland. According to official UK government figures , there were 207,140 police workers in the 43 police forces (England & Wales) on 31 March 2015, and in the same year, based on the findings of this thesis (taking into account non-participating forces) there were roughly about one percent (1%) of crime scene staff of that overall number in operation across the UK.

The role profiles provided by the law enforcement organizations had date stamps on them from various periods dating back to the late 2000s. Many had not been updated in years, and some police forces were unable to provide data altogether. One reason given for with the FOIA request noncompliance (by one of the largest police forces in the UK) was that no new staff had been hired between 2009 and 2015, which were the years requested. There was no uniformity in the wording, ambit of duties, rank and labelling of crime scene staff roles and responsibilities. There was also widespread discrepancy between forces, when it came to the status of crime scene personnel within the police organization, where some were civilians working in conjunction with police professionals, and others where they were expected to be rank-and-file police officers themselves. None of the labels corresponded to police numbers information in the specific headers under which the staff members were listed, or where, if anywhere, forensic science and crime scene investigation personnel were being included. This made it impossible to correlate between publicly available police staffing data released by police.uk, and any forensic science/crime scene personnel data retrieved through FOIA requests in this thesis. It indicated a widespread and jurisdiction wide discrepancy in definitions, roles and responsibilities, police status (whether they were officers or civilians) and classification of crime scene practitioners under officially released staffing data (if at all).

Using the role profiles in law enforcement hiring advertisements and internal human resource department descriptions of desired scene staff qualifications and responsibilities, the chapter identified through analysis of the language used, and the context of the content, the principal

descriptors of scene staff in UK police forces. The main functions of scene staff were found to involve five key aspects: (1) operational support; (2) police organisation and forensic intelligence support; (3) administrative support; (4) community support; (5) organisational support; and (6) investigative support.

The chapter also found a major misconception in the understanding of the role and responsibility of crime scene practitioners as merely evidence collectors, and their functions be purely evidence-based. The cumulative analysis of the role profiles collected from UK police forces, across jurisdictions revealed that scene staff are expected to be victim based, their approach geared towards assisting victims to cope with crime, advising them as to the next steps forward, and consoling witnesses. These functions are rarely reported in research concerning crime scene practice, with overt emphasis on only one of the aspects of their work. Scene staff also were found to undertake responsibilities of ensuring that the legal requirements of processing the scene, such as entering premises with a warrant, ensuring chain of custody, and minimizing contamination and the compromising of evidential artefacts, including the body in homicide cases. The thesis also found that the duties of scene practitioners were dynamic, and required critical thinking in unique scenarios, and that police forces continuously emphasized in the role profiles, that one of the most important qualities they were seeking in potential scene staff was the ability to adapt to unknown scenarios, and react with an open mind.

The enquiry revealed that there was no consistency in the wording, content or context within police forces in the same jurisdiction, with little to no correlation between separate jurisdictions. The roles, requirements for entry, and qualification requirements were dissimilar across the board, with some forces requiring no experience for application for crime scene practice roles. The chapter therefore, constructed an all-encompassing, scalable role profile which police forces can use to advertise for crime scene staff roles, and hire scene workers on an universal standard, rather than setting individual bars and requirements for entry into the vocation. Key discoveries were made about the role of scene staff as community support actors, and their extensive list of tasks which involve not just scientific knowledge, but also legal and investigative comprehension.

The disjuncture between crime scene role profiles and the reality of their roles in practice can only be speculated at this stage, though. Williams (2004; 2008), Kelty et al. (2012), Julian et al. (2012), Robertson et al. (2014), Wilson-Kovacs (2014), and Wyatt (2014) as referenced in the thesis provide useful insight as to their conclusions on the dynamics of scene work, but a direct comparison through observational research is yet to be done. This thesis can be a useful platform to undertake future research, either utilising interviews, questionnaires or even

ethnographic research to answer critical questions as to any disjuncture, or the extent of it, between organisational expectations (which are reflected in role profiles) and the realities of scene work.

Crime scene practice was found to benefit from universally applicable standards within jurisdictions in order to allow for uniformity in the accepted courses for entry into the discipline. It was discovered in the role profiles provided by the forces that completion of various training programs, and institutional schemes were cited as acceptable means of adjudicating competence. This created discrepancy between forces in the same jurisdiction as to the qualification criteria for hiring new crime scene personnel. Without a baseline entry requirement, potential non-standardized techniques, and a varying degree of competence can affect quality of service. There is also no way of comparing experts from multiple law enforcement organizations, as each has its own hiring scheme, with its preferred list of qualifying degrees, courses and training programs. From a performance evaluation standpoint, this is a major hurdle. The solution would thus be centralized curriculums, and nationally enforced standards for all crime scene education providers.

The thesis found that quality control systems in the UK relied heavily on the private sector in order to ensure quality. Organizations such as the Chartered Society of Forensic Sciences have attempted to take the place of defunct state bodies such as the CRFP, but without compellability or a nationally required mandate, practitioners only voluntarily register themselves in the database. From a reliability standpoint, due to the non-regulation of private entities, courts may be reluctant to use such registers as a means of ascertaining competence with regard to experts. The United Kingdom Accreditation Service (UKAS) perhaps has the most important role to play in the entire quality assurance and control system. UKAS was found to collaborate with forensic science and crime scene practice education providers, regulatory structures such as the office of the Forensic Science Regulator, as well as advisory bodies. Their use of ISO standards, especially ISO 17020 was discovered to be lacking for the purposes of crime scene practice due to misconceptions of what quality and competence in crime scene work actually means, and entails. The thesis also uncovered major issues pertaining to the enforcement of standards within law enforcement organizations, with an overreliance on crime scene managers to oversee quality. Monitoring performance and reporting the results of competency testing also left a lot to be desired. The entire system of quality assurance in crime scene work would therefore benefit from a ground-up overhaul, starting with a conceptual understanding of competence. This was addressed in the thesis, with a comprehensive recommendation scheme, with detailed outlines of the challenges that the current system faces, and the implementation hurdles and benefits of the suggested changes.

As a direct consequence of the austerity measures in the UK, where technology has been proposed to be a solution to reducing costs, through mechanization and replacement of human staff for artificial intelligence, the question facing the UK would appear to be, whether forensic science can be automated as a cost cutting measure. In many aspects of the discipline, such as rapid DNA technology, artificially intelligent facial recognition software for CCTV footage, smarter recovery software for digital forensics, and more robust fingerprint matching technologies in law enforcement databases, progress has been made towards a more technological process. However, the question has rarely been asked or examined with regard to crime scene investigation.

The thesis thus conducted an examination of the possibility of mechanizing crime scene investigative practices, its viability, costs, and the potential future of the practice. For a number of reasons, as discussed in previous chapters, such as the complexity of crime scenes, due to their changing nature, shifting properties and the overall chaos from commission of an offense to the discovery of its remnants by crime scene staff, automating the work would serve as a challenge, given the current state of artificial intelligence technology. Despite calls from the judicial and policy actors across jurisdictions to adopt such systems as artificial intelligence, virtual reality and augmented reality, citing directly the VR innovation of the author of this thesis as the future of crime scene investigation (Dixon Jr, 2016; The Atlantic, 2018), the proposed solutions, though promising, would still require human intervention in order to function as intended.

The thesis found that while artificially intelligent systems can recognize objects, and in some ways contextualize them, their inability to make value judgments and rationalize decisions in order to conclude whether an object is evidence, the best manner to collect it based on its degradation state, whether it's relevant evidence, and if it would be worth submitting for analysis, based on a cost-benefit consideration. While such systems could potentially be built, the primary challenge would be to teach a machine to work on provisional hypotheses, running simulations in the background to ascertain which of the hypotheses (based on probabilistic models) would be the most likely scenario in front of it, dismissing the others, and plotting decisions based on the outcomes of the many probabilistic models and their cumulative likelihood ratio.

The PhD also contributed to the wider understanding of the nexus between public bodies and law enforcement through use of FOIL. It demonstrated the need to examine often taken-at-granted occupations and their practitioners, the nature of their work, and the manner in which state intervention and policies can bring shifts to their working practices and futures. The contrasting relationship between science and the law, and their competing objectives brings this

thesis and its findings to the fore, as a preface to the utility of understanding the law-science-society nexus. The law has been argued to want justice, with science seeking truth, and society seeking solutions to problems (Jasanoff, 1995). The establishment of crime scenes as abstract scientific spaces, with their practitioners applying scientific techniques within these spaces, and being subjected to quality standards usually reserved for scientists and science professionals, facilitates further visitation of a long-standing question concerning the role of science in society's public order mechanisms.

SUMMARY OF RECOMMENDATIONS

Based on the findings, it is recommended that robust and effective regulatory authorities be put in place for the appropriate oversight of forensic science, and crime scene practice. The starting point would be reestablishment of the state-run register for qualified crime scene staff, which admits personnel based on competence, issuing appropriate accreditation based on a tiered system of certification and fulfilling yearly proficiency testing and continuing professional development requirements. The forensic science regulator (FSR) should also be afforded complete statutory powers in order to enforce and enact standards in all areas of forensic science, including crime scene investigation. These bodies should work closely with the private sector, and other state organizations to formulate a national strategy for forensic science development, including a common qualification scheme for crime scene practitioners, and an uniform definition of crime scene investigation, what it entails, and the requirements for staff hiring across all law enforcement organizations in the UK.

It is recommended that investment be made on crime scene training equipment, such as virtual reality simulation machines, and mock crime scenes where new and returning scene staff can be tested for competency. Camera equipment such as 360° capture tools, many of which can be bought from consumer sources, can be used to document crime scene work, for future evaluation and learning (Chowdhury, 2017a). Department mandated continuing professional development would also assist in the latest techniques and technologies being adopted by scene staff in their working practices, improving overall quality, and establishing a uniform standard operating procedure across jurisdictions.

Uniformity in recommendations, practice and enforcement of policies would need to be well-thought-out and be scalable for police forces large and small. Education schemes can be set up to inform law enforcement professionals unfamiliar with the complexity of crime scene work, and the potential, scope and boundaries of forensic science, to harmonize the relationship between the supposed backroom boys, and those who consider themselves to be real police on the front lines.

This thesis found that the roles and responsibilities of crime scene staff goes far beyond merely collecting and storing evidence and underlining this finding through communication of a comprehensive list of duties undertaken by scene workers can allow investigators and detectives to get the most out of them. This would benefit a wide range of actors, including law enforcement, the courts and victims of crime. However, in order to fully utilize this knowledge scheme, legal professionals, such as crown prosecution service staff, defence barristers, and even judicial actors such as judges, magistrates and to a lesser extent juries during trial, would require varying degrees of understanding of crime scene work, and its practitioners.

On the subject, knowledge management systems within police forces would require an extensive overhaul so that financial spending in forensic science is annotated and labelled under the same uniform code as every other force in the UK. The thesis found that forces across the board, have dissimilar knowledge management systems, of varying complexity and levels of success (by their own admission) to retrieve information, such as financial spending data and performance information on crime scene staff, forensic science lab work spending, and overall scientific support spending. The recommendation is that a national, all-connected database of human resources (HR), and financial departments within law enforcement organizations be established, with a mandatory requirement for information updates on staff hiring, changes, financial spending, and performance information. This would ensure that any policy decisions by the oversight and regulatory organizations is based on the most up-to-date information, well-informed by hindsight, and supported by facts. It is only through a series of checks and balances that forensic science can be protected from potential erosion and corruption from lofty expectations and a countering lack of resources, and oftentimes faith in its own validity and value.

The principal challenge facing academics and policymakers surrounding the recommendations in this thesis revolve around police practices, and the wider culture of state focus and investment on frontline policing, which is more politically and aesthetically visual, rather than long-term systemic improvements which trickle down to the so-called backroom staff. The latter often is a time-dependent and gradual process where the improvement gains are not immediately visible. In modernism, management culture has encroached upon every facet of organisational practice, where cost-cutting and resource allocation according to need, has driven decision-making over any overriding or overarching concerns about justice. Improvement of data management practices and data sharing systems, one of the most important recommendations of this thesis, would require a change in working practices, additional training, and a significant investment in the information-handling infrastructure of all 45 police forces in the UK, as well as a data monitoring pipeline between executive branch organisations, and the same. Performance indicator sharing and opening budget and

expenditure books to oversight organisations, another recommendation of this thesis, could place law enforcement organisations under the watchful eye of policymakers, instigating potential fears of closer supervision and stunting of the current process of their work. However, an overhaul of current working practices, knowledge regimes and integration practices in these organisations is long overdue and if scene work and policing are to achieve a truly symbiotic relationship, utilising the benefits that such a dynamic could bring, changes must be made from the state, organisational, to the individual level.

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